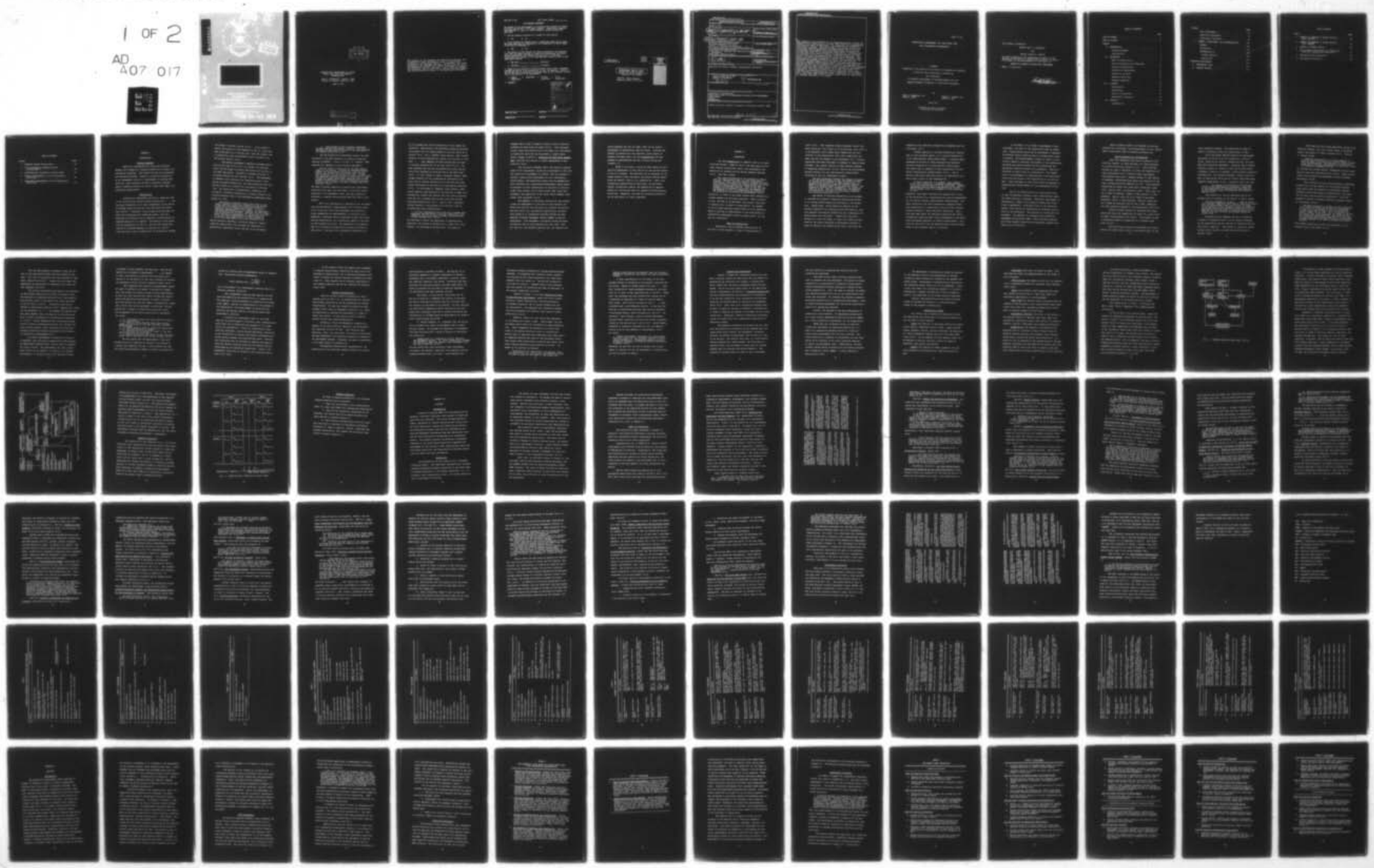
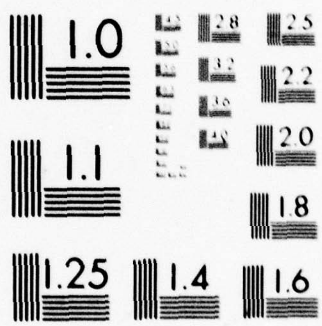
AD-A073 017 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL--ETC F/G 13/2
PRODUCTIVITY MEASUREMENT IN A BASE LEVEL USAF CIVIL ENGINEERING--ETC(U)
JUN 79 G P BAUMGARTEL, T D JOHNSON
UNCLASSIFIED AFIT-LSSR-17-79A NL

1 OF 2
AD
A073 017






MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

# PRODUCTIVITY MEASUREMENT IN A BASE LEVEL USAF CIVIL ENGINEERING ORGANIZATION

Gary P. Baumgartel, Captain, USAF
Thomas D. Johnson, Captain, USAF

LSSR 17-79A



79 08 23 099

USAF SCN 75-20B AFIT Control Number ____________

AFIT RESEARCH ASSESSMENT

The purpose of this questionnaire is to determine the potential for current and future applications of AFIT thesis research. Please return completed questionnaires to: AFIT/ LSH (Thesis Feedback), Wright-Patterson AFB, Ohio 45433.

1. Did this research contribute to a current Air Force project?

a. Yes b. No

2. Do you believe this research topic is significant enough that it would have been researched (or contracted) by your organization or another agency if AFIT had not researched it?

a. Yes b. No

3. The benefits of AFIT research can often be expressed by the equivalent value that your agency received by virtue of AFIT performing the research. Can you estimate what this research would have cost if it had been accomplished under contract or if it had been done in-house in terms of manpower and/or dollars?

a. Man-years ________ $ ________ (Contract).

b. Man-years ________ $ ________ (In-house).

4. Often it is not possible to attach equivalent dollar values to research, although the results of the research may, in fact, be important. Whether or not you were able to establish an equivalent value for this research (3 above), what is your estimate of its significance?

a. Highly Significant b. Significant c. Slightly Significant d. Of No Significance

5. Comments:

| Accession For | |
|---|---|
| NTIS GRA&I | ✓ |
| DDC TAB | |
| Unannounced | |
| Justification ______ | |
| By ______ | |
| Distribution/ | |
| Availability Codes | |
| Dist | Avail and/or special |
| A | |

________________________ ________________________
Name and Grade Position

________________________ ________________________
Organization Location

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

**BUSINESS REPLY MAIL**
FIRST CLASS PERMIT NO. 73236 WASHINGTON D.C.

POSTAGE WILL BE PAID BY ADDRESSEE

AFIT/LSH (Thesis Feedback)
Wright-Patterson AFB OH 45433

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

| REPORT DOCUMENTATION PAGE | | READ INSTRUCTIONS BEFORE COMPLETING FORM |
|---|---|---|
| 1. REPORT NUMBER<br>LSSR 17-79A | 2. GOVT ACCESSION NO. | 3. RECIPIENT'S CATALOG NUMBER |
| 4. TITLE (and Subtitle)<br>6 PRODUCTIVITY MEASUREMENT IN A BASE LEVEL USAF CIVIL ENGINEERING ORGANIZATION | | 5. TYPE OF REPORT & PERIOD COVERED<br>9 Master's Thesis |
| | | 6. PERFORMING ORG. REPORT NUMBER |
| 7. AUTHOR(s)<br>10 Gary P. Baumgartel, Captain, USAF<br>Thomas D. Johnson, Captain, USAF | | 8. CONTRACT OR GRANT NUMBER(s) |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>Graduate Education Division<br>School of Systems and Logistics<br>Air Force Institute of Technology, WPAFB OH | | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS |
| 11. CONTROLLING OFFICE NAME AND ADDRESS<br>Department of Research and Administrative Management<br>AFIT/LSGR, WPAFB OH 45433 | | 12. REPORT DATE<br>11 June 1979 |
| | | 13. NUMBER OF PAGES<br>121 |
| 14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)<br>12 133 p. | | 15. SECURITY CLASS. (of this report)<br>UNCLASSIFIED |
| | | 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE |

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

JOSEPH P. HIPPS, Major, USAF
Director of Information

14 AFIT-LSSR-17-79A

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

PRODUCTIVITY MEASUREMENT
BASE LEVEL USAF CIVIL ENGINEERING PRODUCTIVITY MEASUREMENT
PERFORMANCE
GOALS
OBJECTIVES

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Thesis Chairman: Ronald E. Knipfer, Lieutenant Colonel, USAF

012 250

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

The purpose of this research was to determine whether a model for measuring the productivity of a base level USAF civil engineering organization could be developed. The research was conducted in two distinct phases. The first phase was a review of existing literature concerning productivity measurement and led to the development of a productivity measurement model applicable to a base level USAF civil engineering organization. Productivity was defined as the ratio of actual to desired results, divided by the input for the organizational level being measured. The model is a three tiered structure consisting of strategic level organizational goals, supported by branch level objectives, and evaluated by performance indicators which are the ratio of actual to desired results which support the goals and objectives. The second phase of the research was a review of Department of Defense and Air Force literature in order to identify the strategic level organizational goals, branch level objectives, performance indicators, and input information for a base level USAF civil engineering organization. This second literature review identified the goals, objectives, and input information for the model, but it was found that existing actual output data is insufficient to complete the model in all areas.

LSSR 17-79A

# PRODUCTIVITY MEASUREMENT IN A BASE LEVEL USAF CIVIL ENGINEERING ORGANIZATION

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Facilities Management

By

Gary P. Baumgartel, BS
Captain, USAF

Thomas D. Johnson, BS
Captain, USAF

June 1979

Approved for public release;
distribution unlimited

This thesis, written by

Captain Gary P. Baumgartel

and

Captain Thomas D. Johnson

has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN FACILITIES MANAGEMENT

DATE: 13 June 1979

Ronald Kuyper

COMMITTEE CHAIRMAN

## TABLE OF CONTENTS

Chapter | Page

## LIST OF TABLES

## LIST OF FIGURES

# CHAPTER I

# INTRODUCTION

## Problem Statement

USAF Civil Engineering has tried many different methods for attempting to measure productivity of base civil engineering squadrons. Each method has met with resistance and has been discarded. Despite a continuing recognition at all management levels of a requirement to evaluate productivity, there currently exists no generally accepted means to measure productivity within a base level USAF civil engineering organization.

## Justification

Productivity measurement has been an important task in the United States economy because productivity ". . . has long been recognized [as a] basic determinant of the amount of economic goods and services that the Nation has available [26:12]." Therefore, rising productivity provides the basis for increasing real income per worker, acts as a deterrent to inflation, and is important in maintaining the competitiveness of U.S. exports. The decline in the growth rate of productivity in the U.S. over the last decade has created an increased emphasis on productivity (69:18). "Over the past 5 years, productivity of the American economy

has become a national concern [31:1]." If we intend to retain the quality of life standard in the U.S. which has been established as a national goal, then the current rate of productivity must be enhanced in both the public and the private sectors (12:1).

The federal government's spending increased nearly $50 billion from 1972 to 1977 (in current 1977 dollars) while the DOD budget allocation declined by $17 billion in the same time period. Therefore, increased attention to in-house productivity has resulted (31:3). The Department of Defense, fully realizing its responsibilities in promoting increased productivity, has used guidelines from the National Center for Productivity and Quality of Working Life. The importance of understanding, measuring, and ultimately increasing productivity is clearly stated in the following extract from a Vice Presidential Memorandum dated August 10, 1976:

> The Federal Government should take pride in this effort [National Center for Productivity and Quality of Working Life productivity reporting program] to report on its own productivity growth. It is an important demonstration of our concern for government efficiency and effectiveness. However, the mere reporting of productivity trends is not sufficient to bring about the rate of improvement our Nation requires. It is still the responsibility of each manager to strive for improvement within each activity [31:6].

Deputy Assistant Secretary of Defense Jacques S. Gansler (Material Acquisition) also stressed the importance of productivity improvement within the DOD in his statement:

> . . . the economy of every resource commitment we make--whether procurement, material, facilities, or manpower dollars--may be crucial to the attainment of our defense objectives [12:1].

The DOD productivity enhancement concern has been reflected in the USAF promotion of continual effective resource management. Louis L. Wilson, Jr., General, USAF, captured this emphasis in the following statement:

> The Air Force is facing one of the most austere times in its history. In spite of increased defense budgets our buying power has eroded, with the net result that we have to do more with less. To meet this challenge, we need to fully utilize our most costly and important resource--people--by instilling in them a sense of urgency about their important role in the conduct of the Nation's critical enterprise--national security--and in doing so we must increase their productivity [78:2].

The USAF's constant emphasis on productivity improvement, doing more with less, and efficiency in utilizing scarce resources in all management areas, has been constantly reflected in numerous articles published from 1976 to the present.

USAF civil engineering is responsible for the operation and maintenance of approximately $17.8 billion worth of Air Force base facilities throughout the world at an annual expenditure of approximately $1.3 billion (10:2). Therefore, inefficient use of resources by USAF civil engineering organizations has a significant impact on the overall DOD productivity level. The importance of increasing USAF civil engineering productivity has been reflected in past policy. The major civil engineering objectives for

FY 69 included work force productivity as the number one objective. Specifically, the objective called for increasing productivity and effectiveness of the work force by 15 percent (5:3). Guy H. Goddard, Major General, USAF (former Director of Civil Engineering) stated in an article in 1970 that, ". . . much emphasis has been placed upon the need to increase productivity of our work force [15:1]." He also stressed that the key to productivity within the Air Force Civil Engineering structure was at the base level (15:1). In 1970, Archie S. Mayes, Brigadier General, USAF, (former Director of Civil Engineering) presented a six-point plan to improve productivity of the work force and overall efficiency of the base civil engineering operation (27:2). In 1975 Robert C. Thompson, Major General, USAF, having recently been selected as the Director of USAF Civil Engineering, stated that looking into the future indicated that the civil engineer must do more with less through increased productivity (40:1). Also in 1975, Lieutenant Colonel Norwood J. King stated in his article, "How to Increase Work Force Productivity,"

> If civil engineering activities are to become more efficient and effective, to be more competitive with commercial forces, we must increase the productivity of our in-house force [22:6].

He continued to stress the importance of understanding, measuring, and increasing productivity in USAF civil engineering. He concluded by stating that, "the American

taxpayer has a right to expect a dollar's worth of service produced for each dollar we spend [22:8]." This continual concern about the productivity of the USAF civil engineering in-house work force has not diminished in recent years. Recent changes to AFR 85-1, Resources and Work Force Management, resulted from efforts to reduce impediments to productivity (28:2).

The now extinct BALANCE (Basic and Logically Applied Norms--Civil Engineering) system was established in 1966 with the objective of management by results, and was intended to provide a quantitative measurement of civil engineering effectiveness. The experience gained from the BALANCE program indicated that a performance measurement system should be designed to avoid concentration on function or activity rather than mission; use of input rather than output measurements; and imposition of Air Force, major command, wide output level standards (5:2-6).

The emphasis on increasing productivity has created a need for measurement in this area so that managers can effectively monitor the efficiency of resource utilization. The base level civil engineering organizations currently rely primarily on information provided through the Base Engineer Automated Management System (BEAMS) to monitor performance. This management information system provides information such as total manhours per work order, cost per facility, and estimated manhours per job compared with

actual manhours per job (to name a few) but an overall measurement of productivity does not exist. Although the subject of productivity has received a great amount of emphasis for many years, the term productivity has been misused or misunderstood and has virtually defied measurement (1).

Based on the above, a definite need exists for productivity measurement in both the public and private sectors of the U.S. economy. The efficient use of resources at the lowest levels of both the public and private sectors determines the overall trend in U.S. productivity. USAF civil engineering organizations at base level, as previously stated, collectively control the expenditure of approximately $1.3 billion per year for operating and maintaining facilities. Therefore, the need for evaluating productivity at this level is vitally important.

## CHAPTER II

## BACKGROUND

The term <u>productivity</u> is commonly used in an industrialized society. However, due to the wide usage of this term, varying connotations result, and consequently the definition of productivity has become somewhat obscured (25:4). Paul Mali stated,

> The views of productivity for purposes of definition and understanding have not been consistent or uniform. In fact, the many views of productivity have contributed to confusion and obscurity about its nature. Years of seeking productivity growth should have yielded an acceptable meaning. This is not the case, probably due to different positions and emphasis in the degrees of skill in interpreting and looking at the productivity processes and measurements [25:4].

Therefore, in order to gain some insight about productivity, we must address the following questions. What is productivity? How may it be measured? And finally, what does it actually tell us about an organization? An attempt to answer these questions should prove to be an effective means of gaining an understanding of the significance of productivity measurement within an organization, its use, and its limitations.

### <u>What is Productivity?</u>

Productivity may be defined quantitatively as the ratio of some measure of output to some measure of

input (15:2). This seemingly simple statement raises four major questions: what output is to be measured; what input is to be measured; which output-input comparisons are most relevant to the organization; and, after comparisons are made, how are the results to be interpreted (9:7)? Various approaches have been developed in attempts to resolve these problems. But, before looking at these specific methods of measuring productivity, we will look at the relationship between productivity and organizational effectiveness. According to the U.S. Department of Labor,

> The main difference between the concepts of productivity and effectiveness is that the former includes no evaluation in relation to some overall goal. A measure of productivity does not indicate anything about the appropriateness of the activity itself. The program or activity and, consequently, the output is taken as given. Thus an interest only in questions of productivity can result in efficiently carrying out the wrong functions [76:6].

One method of defining productivity in an attempt to overcome the problem of measuring misdirected efforts is to include effectiveness and efficiency in the definition. George Kuper, Acting Executive Director of the National Commission on Productivity and Work Quality, took this approach and defined productivity as a combination of effectiveness and efficiency. Productivity was still defined as a ratio of output to input, but output was measured as the results obtained or performance achieved in terms of reaching the organizational goals, and input was

measured as the resources consumed which depended upon the efficiency (25:7).

Another approach to relating productivity measurement to goal-oriented results is to include productivity in an organizational effectiveness model. A process model developed by Richard M. Steers employed this method of relating productivity to organizational effectiveness. This model used an approach of goal optimization for measuring organizational effectiveness (35:57). Due to multiple and often conflicting goals, an organization will never reach a point of goal maximization:

> In most situations, for example, there appears to be little chance for a company to maximize productivity and job satisfaction at the same time. Instead, compromises must be made--compromises that provide for an optimal level of attainment of both objectives [35:58].

Therefore, this model indicates that productivity is one of the objectives of an organization but must be compromised for the overall optimal organizational effectiveness. The other objectives with which productivity competes differ from organization to organization along with the relative weights assigned to these individual objectives. There have been many models for measuring organizational effectiveness but there has been little consistency in the objectives considered important to overall effectiveness. Productivity was one of the two objectives most often incorporated in the different models (34:546-558).

If the model is to include a measurement of goal attainment, the goals of the organization must be identified. Organizational goals can be considered to represent the desired future conditions which an organization wants to achieve. The establishment of goals is useful in providing a sense of direction and purpose to the organization. The goals are usually general and are transferred into operational objectives which can be measured. There is a hierarchy of goals within an organization. The highest level is the strategic or organizational level goals which relate the activities of the organization to its environment. Goal attainment at this level should be measured if organizational effectiveness is to be determined (20:155-166).

One of the difficulties that organizations face is that the abstract strategic level organizational goals are often difficult to measure. Therefore, measurement of performance in terms of more specific operational objectives is emphasized. Continuous focus on the objective, though, often results in neglecting the strategic goals in favor of the objectives. This process is called goal displacement. One approach to overcoming this problem is management by objectives (MBO), which requires directing activities towards objectives and objectives towards strategic goals (20:155-166).

Having looked at some of the methods of relating productivity, efficiency, and effectiveness, we will explore some of the methods used for measuring productivity.

## How Can Productivity be Measured?

Bela Gold suggested three ways of looking at productivity studies: as input-centered, as output-centered, or as point efficiency studies (16:13). Input-centered studies are used to determine the level and composition of input requirements and to minimize these requirements. "The measures used tend to compare changes in some measure of aggregate, undifferentiated output with measures of the input of some particular resource [16:13]." Input-centered studies may be broken into three major categories: labor input, capital input, and materials input. Labor input can be in terms of manhours, number of wage earners, or wage payments. Capital input can be in terms of buildings, machinery, tools, or bank balances. Material inputs can be in terms of resources such as coal, steel, chemicals, and other products supplied to the organizations (16:15-31).

Output-centered studies are concerned with determining the level and composition of output to a given level of input, and maximizing this output. This method is used to determine production capacities at a constant input level (16:40).

Point-efficiency studies are concerned with determining the output-input ratio of a particular point in the

total production process. This method may be used for resource allocation within the organization (16:48).

Eilon and Soesan defined productivity measurement approaches as falling into four categories: financial ratios, productivity costing, transfer pricing, and other empirically-oriented approaches. Financial ratios compare financial outputs to financial input and include profit/investment (return on investment), profit/revenue (operating profitability), and revenue/investment (capital turnover). Each of these major ratios may be further subdivided among component departments (9:7-8). Financial ratios are used

> . . . as a means of circumventing the problems rooted in the heterogeneity of physical inputs and in the difficulties of assessing the contributions of the different inputs of producing the products in question [9:7].

The productivity costing approaches define the productivity of a product as its ability to make a profit.

> The basic assumption is made . . . that an industrial system's operating costs remain essentially stable over the whole normal range of variation of output in the system and that, therefore, once the productive facilities have been identified, productivity can be measured by total earnings of those productive facilities and the rate at which each product generates profit [9:8].

Transfer pricing compares the cost of producing a product or component which is to be further processed by the organization against the cost of obtaining the product from a competitor. This method is limited to organizations which transfer a product from one division to another (9:10).

Other empirically-oriented approaches include value added per product, unit cost, actual output to potential output, and percent of output rejected (9:11). William T. Stewart stated:

> Measuring productivity in a large organization would be easy if a simple ratio of work output to input could be established. Unfortunately, with contributions coming from many departments and production lines, the simplicity disappears [36:34].

To overcome this problem Stewart recommended ranking organizational goals and assigning utility values. These utility values allow productivity measurement through surrogate measurement (36:34).

While looking at these various methods of measuring productivity, we must explore the relationship between organization type and productivity measurement methods. Greenburg listed three types of organizations: the plant, the job shop, and the service organization. The plant produces a variety of products which may gradually change as time passes (18:15).

> The basic principle to be kept in mind in developing a system of output and productivity measurement is that all units produced by the firm are related to each other, more or less. If it is possible to place a "value" on one unit, then it should be possible to "value" other units produced. The values of the units should be conceptually equivalent to each other in a way which meets the basic objective of developing an output measure to be used for productivity ratios [18:16].

This product equivalency allows the measurement of the constant dollar value added (18:17).

The job shop presents a problem in that the outputs of one time period differ from the outputs of the next. This lack of similarity over short periods of time makes comparison difficult. Outputs must be broken into components and equivalency of components over time, and then compared (18:31-35).

The service organization may break up its services as identifiable physical units and/or intangible units. The procedure for measuring productivity of the identifiable physical units is the same as for either the plant or the job shop (18:40-41). Intangible units may be reduced to identifiable physical units, compared over industry job standards, or ". . . the manager can observe and make some judgment about the quality of work and may be able to install procedures for monitoring and measuring it [18:42]." Heaton emphasized that calculating productivity in service organizations should also consider the total service process, where timeliness of actions and customer satisfaction should be assessed and included in the productivity measurements (19).

The actual measurement of productivity factors is dependent upon the type of productivity study desired, the measurement approach taken, and the type of organization being studied. The measurements may take on many forms--from cost per manhour, to index or unit manhour requirements, to operating profit per operating assets,

to percent of goal achieved, and many more. The use and feasibility of methods of measurement ". . . will depend on their relationship to existing cost accounting procedures or on the ability of the firm to modify its accounting procedures without incurring excessive costs [18:5]."

Mali suggested that productivity measurement should be aimed at assessing the amount of productivity change over time rather than simply relying on point measurements. He also felt that productivity should include both quantitative and qualitative assessments of output (25:80-82). Mali also pointed out that the number of productivity output-input ratios that can be developed is unlimited. He suggested that a number of productivity gains are likely and recommended the following guidelines for developing the ratios:

> 1. Use several ratios that have historic validity for the organization.
> 2. Build in ratio measures while the work processes for productivity are being designed, planned, and developed.
> 3. Change general terms to quantified expressions to tell how much and what is needed.
> 4. Focus the ratio toward the output of the process rather than its activities.
> 5. Select ratios that are useful at the firm level rather than at the macro level of the economy [25:84].

He also stated that the measurement of the total productivity of an organization should not be limited to a single ratio measure, and that a total productivity measure could be developed by summing a series of productivity

ratios for various units or departments within an organization. The series would be expressed as

$$\text{Total productivity} = \sum_{n=1}^{k} \left(\frac{P_n}{R_n}\right) / k$$

for k units where P is a performance indicator and R is a resource indicator (25:92-93).

Mali recommended using the MBO approach for managing and measuring the productivity of an organization. This approach, called management of productivity by objectives (MPBO), requires an understanding of the purpose of the organization, the establishment of objectives for achieving the desired results, and making output-input measurements (25:45-46).

A productivity measurement model of this type requires the establishment of strategic level organizational goals which can be understood and accepted at all levels within the organization. After the organizational goals have been developed, clearly defined operational objectives at the coordinative or branch level must be developed which direct results towards the organizational goals. Performance indicators must be developed to measure the degree to which the results obtained agree with the desired results established by the operational objectives. Finally, the performance level must be related to the resources used to attain that level.

In 1974 Captain Arnold and Captain Fink attempted to develop organizational objectives for base level civil engineering organizations, and to develop performance indicators to assess the results achieved in meeting the objectives (4). Their results are not directly applicable to this research because they did not identify the organizational goals.

## Further Considerations

Thus far we have looked at productivity from a systems point of view; i.e., by establishing the relationship between productivity and the organization's optimal effectiveness. We have also looked at productivity measurement from a macro or aggregate viewpoint; i.e., defining approaches to productivity measurement in terms of inputs and outputs. At this point we need to explore several factors that affect productivity.

According to Kast and Rosenzweig, productivity depends on two major factors: employee's job performance, and resources utilized (20:255). The resources (raw materials, plant, and technology) are normally quantifiable and were addressed in the previous discussion of productivity measurement methods. Therefore, we need to concentrate on the human inputs to productivity.

"Disregarding technological considerations, the productivity of an individual depends primarily on ability

and motivation to perform [20:256]." The ability of an individual depends on a complex combination of factors including: skill, knowledge, experience, training, interest, physical condition, and values. Motivation and work attitudes are even more complex, and many ideas about the effect on productivity and ways of improving employees' job performance have been proposed (20:256).

Tom Lupton, in his article "Efficiency and the Quality of Worklife," suggested the joining of engineers and social scientists to design jobs for efficient work but catering to the needs of the workers. He also realized the difficulty of measuring worker satisfaction but proposed that a personal interview of workers concerning job satisfaction be included among the measurements of organizational effectiveness (24:68-80).

C. Jackson Grayson, Jr., suggested that the definition of productivity should be broadened from an output-per-man concept. He stressed the importance of management attitudes and practices in terms of effects on motivation and creativity.

> Productivity is a combination of men, machines, and management methods. So, total productivity includes the effects of labor and capital, plus management know-how and innovations [17:31].

He also stated that union practices, human investments (training), and workers' incentives were important factors affecting productivity (17:30-36). David McClean also

discussed increasing productivity through worker-oriented programs. He suggested that "economic reward, personal job satisfaction and future opportunity are three basic elements that turn people on. Failure and frustration turn them off [29:66]." Raymond Katziel also indicated that the rewards for effective work must be meaningful to the workers themselves (21:69-75).

Edward M. Glaser, in his book Productivity Gains Through Worklife Improvements, agreed that work climate-structure, career opportunities, and decision-making involvement frequently led to greater productivity and job satisfaction. He suggested that cooperation between labor and management was essential when trying to boost productivity (14:12).

Edward E. Lawler III also stated the importance of job design and workers' needs. Some workers like job enrichment while others are satisfied with mass production work. Lawler suggested the possibility of having both types of job designs available within an organization. Another area of importance was leadership style where again he suggested matching the style to the individual worker. Some workers need authoritarian direction and control while others require democratic participation (23:19-29). He summed up his position by stating,

> Organizations can change their job designs, selection evaluation, pay, work hours, and leadership styles in order to adapt to the needs of individuals and

> thereby create working environments that will be more effective, satisfying, motivating, and less alientating [23:29].

A final consideration is the effect of the measurement method or technique on the workers' attitudes and motivation. Edward M. Glaser pointed out that ". . . the word 'productivity' means management pressure to get more work out of labor as many employees see it [14:25]." Therefore, job standards and many productivity studies can be interpreted by employees as a means of forcing them to work harder. David Sirota pointed out that ". . . [job] standards have a self-defeating quality: in the long run, they act to discourage precisely what they are designed to encourage--namely, worker productivity [32:111]." He suggested a more flexible, output-oriented measurement approach where incentives are given for overall increased outputs at the section level (32:111-116). Gerald Nadler, Professor of Industrial Engineering, also saw negative results from too much emphasis on measurements (30:2). He stated:

> Present measurement techniques just scare people. They know others who are adversely affected by their limited perspective. Measurement emphasis alone in industrial engineering creates pollution--bad effects on people [30:25].

Therefore, we see that not only do people have a great impact on productivity but the measurement of productivity can have an effect on people.

## Productivity Measurement

Chapter I showed that increasing productivity has been a national concern for many years and that USAF Civil Engineering has reflected this concern in productivity goals, objectives, and policy statements during the past decade. One of the five current goals of the USAF Directorate of Engineering and Service is Increased Productivity. The goals established by the Directorate are considered to be the key concerns of civil engineering and services, requiring the maximum amount of attention and management effort (8:2). Base level civil engineering managers must be able to assess an increase or decrease in productivity in order to identify the degree of attainment of this Directorate goal. Therefore, a method of measuring the productivity of a base level civil engineering organization is definitely needed.

The preceding discussion of productivity has shown that the definition of productivity has depended upon the organization being studied, the management information desired, the method of measurement, and the point of view of the definer. The opinion that there is a relationship between productivity, effectiveness, and efficiency is generally held, but the manner in which they are related depends upon the interest and desired emphasis. The problem of relating output to input to goal achievement

and the necessity of insuring that activity be goal directed was discussed.

The need to stay within existing accounting systems if possible was also addressed. The amount of change required in an organization's information system should receive consideration before developing a method of measuring productivity. Also, the need to consider the effect that measuring productivity has on the organization's personnel was discussed. To overcome the problem of possibly decreasing productivity by inappropriate measurement, result or output-oriented measurement for the entire organization might be an appropriate approach.

Finally, the problem of how many measurements of productivity was discussed. An appropriate method would be to have several measurements that would then be summed for a total productivity measurement for the organization.

Based upon the literature review, we have concluded that the method for measuring productivity in a USAF civil engineering squadron should be a series of output-input measurements that are goal oriented. The output should be an indicator of performance and the input should be an indicator of the total resources required to obtain the performance level. Additionally, the measurement method should interface with the existing management information system (BEAMS), to avoid additional administrative work.

The measurement of productivity should be centered at the strategic level of the organization to provide information about productivity changes at the squadron and branch levels. Measurement of productivity at the section and individual worker levels will not be addressed. Since a base level USAF civil engineering squadron is a service organization, customer satisfaction as well as quantity, quality, and timeliness of the output should be measured.

Finally, the productivity ratios should be established to evaluate and analyze, on a recurring basis, trends of the changes in productivity.

## Definition of Terms

For clarity and to resolve the conflicts of varying definitions and terminology, the following definitions will be used for this research.

Input--the quantity of resources used by the organization during a specified period of time. Inputs include energy, manpower, dollars, natural resources, and materials. All inputs aggregated together must be of the same dimensional units. For the purpose of this research inputs will be measured in dollars, and will include all types of resources, both direct and indirect.

Output--the quantity of goods, products, and services produced or provided during a specified period of time.

Efficiency--the ratio of output to input. This term does not imply the appropriateness of the output to goal attainment.

Effectiveness--the measure of how well an organization is progressing towards its strategic level organizational goals.

Goals--the strategic level organizational goals that relate the activities of a base level USAF civil engineering organization to its environment.

Objectives--the desired future conditions that are subgoals of the strategic level organizational goals which a base level USAF civil engineering organization branch wants to achieve through its activities.

Performance Indicator--the ratio of the actual to the desired output of a specific base level USAF civil engineering organization branch level activity in terms of quantity, quality, timeliness, and customer satisfaction.

Productivity--the measure of the effective and efficient use of resources to attain results which are directed towards achieving the strategic level organizational goals, through the branch level objectives. Productivity will be measured as the average value of the performance indicators for each objective divided by the total resources used to attain the level of output of the specific branch level activities contributing to each objective.

As stated previously, output measurement in a service organization is normally very elusive. The outputs are often obscure and are not countable, physical products. USAF civil engineering managers often attempt to get a feel for how well they are accomplishing their mission by relying on a variety of output and input indicators available from various sources which include BEAMS, status charts, briefings and manual records. The measurement of output generally centers on branch or section activities, and the objectives of the branch are often ignored.

The process model in Figure 1, developed from Mali's model (25:49), represents this feedback system pictorially.

As can be seen in this process model, inputs and outputs are compared to standards or desired levels, and action is taken if the difference between the actual and desired inputs or outputs are significant to the manager. Output to input comparisons are sometimes used, but many of the information sources deal only with outputs or inputs. Also there is no formal link between goals and desired results, and no comparison process between actual results and desired results. This is generally the case in service organizations because goals are often obscured and a formal statement of desired results is often nonexistent (3:141). This situation presently exists within base level USAF civil engineering squadrons (11:70-80).

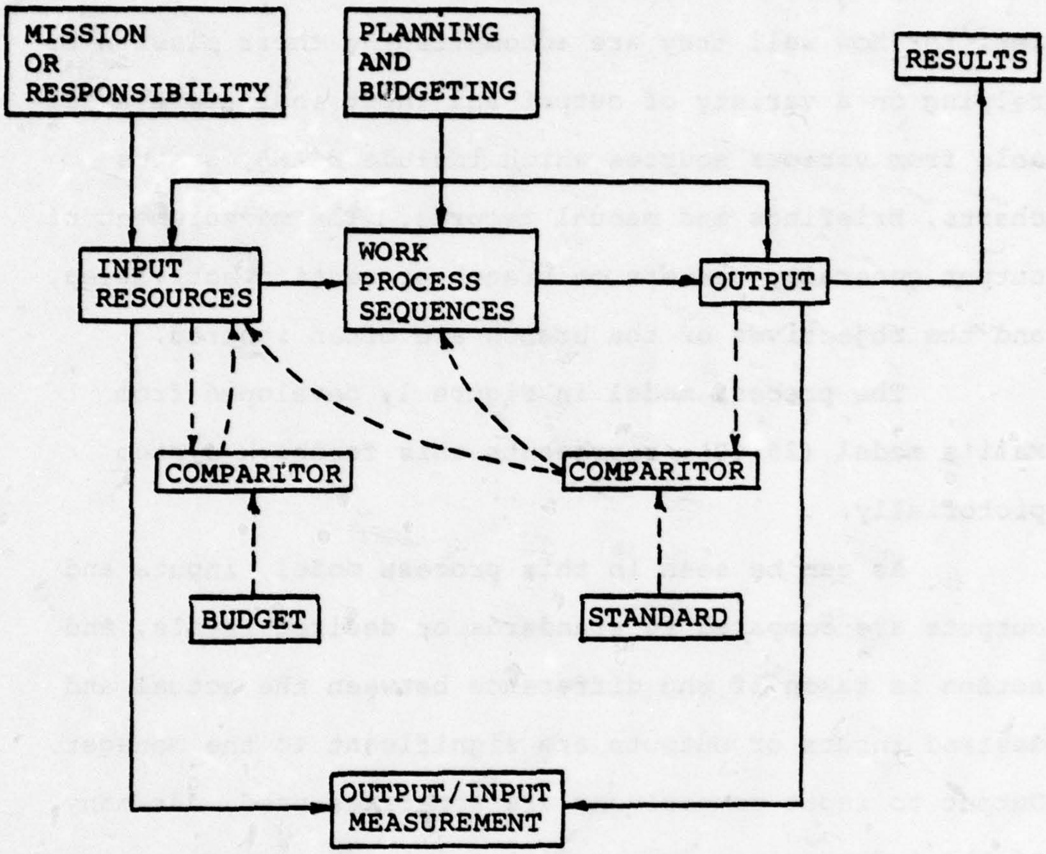



Fig. 1. Feedback System Process Model (25:49)

Our productivity model expands the process model of Figure 1 to include these overlooked yet vitally important functions. A formal statement of strategic level organizational goals, more specific branch level objectives, and specific results of combinations of activities supporting these objectives will be the vehicle used to close this link. Figure 2 represents the process model we have used to incorporate these omissions. As can be seen, in addition to the desired results of the base level USAF civil engineering organization activities, a formal statement of the desired results of the organization's activities as perceived by higher headquarters, base/wing commanders, and serviced organizations and individuals are included.

Therefore, to measure the productivity of a base level USAF civil engineering organization, a productivity measurement model based upon a network of performance indicator/input ratios will be used. As defined previously, the performance indicators will be ratio of actual to desired outputs of specific civil engineering branch level activities in terms of quantity, quality, timeliness, and customer satisfaction. The inputs will be the total resources, in dollars, used to obtain the output of the specific branch activities. Input information is available directly from the automated products from the Base Engineer Automated Management System (BEAMS), as outlined in AFM 171-200, and the Resource Management System automated

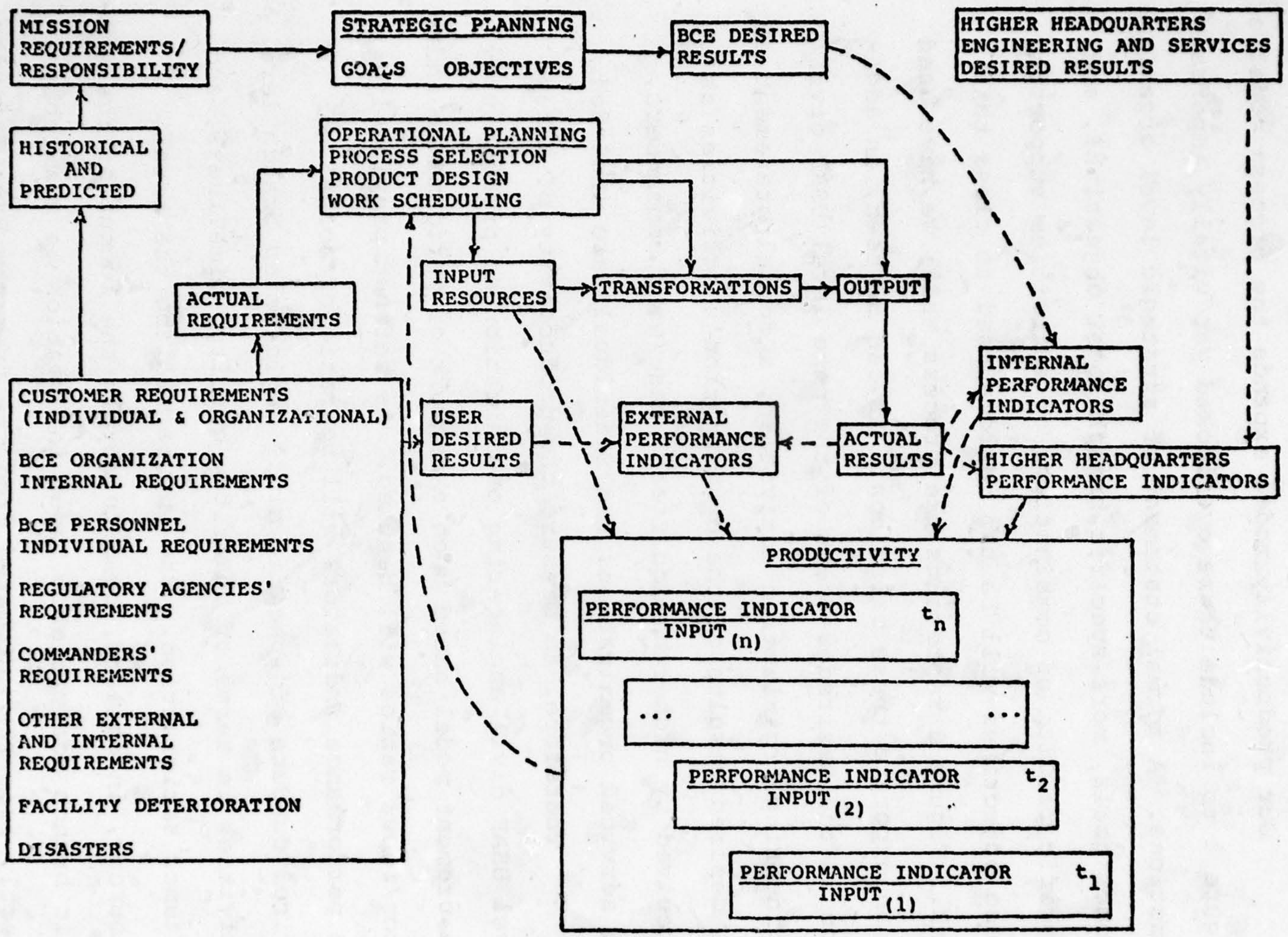



Fig. 2. Civil Engineering Feedback System Process Model

products as outlined in AFM 178-6. Therefore, the productivity measurement will be accomplished at the organization and branch levels, and will not directly measure individual worker productivity. The productivity measurements will be computed periodically and can be compared to previous period measurement to allow for trend analysis. This model is depicted in Figure 3. The productivity for a branch is equal to the sum of that branch's performance indicators for all of its objectives and goals, divided by the total number of performance indicators, divided by the total input to the branch, expressed in dollars. The performance indicator must be designed such that its value increases as objective achievement is approached.

## Research Objectives

The objectives of this research are to: (1) develop strategic level organizational goals and branch level objectives of a BCE organization through synthesis of published Department of Defense (DOD) and Air Force (USAF) policy directives and guidance, and (2) to determine if branch level activity output data in terms of quantity, quality, timeliness and customer satisfaction is currently recorded manually or through automated systems to establish performance indicators to complete a productivity measurement model for a base level USAF civil engineering organization matching the general model developed previously.

| | GOAL 1 | | ... | | GOAL r | |
|---|---|---|---|---|---|---|
| ELEMENT | OBJ | PERF IND | OBJ | PERF IND | OBJ | PERF IND |
| BRANCH 1 | $O_{1,1,1}$ | $PI_{1,1,1,1}$ | | | $O_{1,r,1}$ | $PI_{1,r,1,1}$ |
| | | ⋮ | | | | ⋮ |
| | | $PI_{1,1,1,t}$ | | | | $PI_{1,r,1,t}$ |
| | ⋮ | | | | ⋮ | |
| | $O_{1,1,s}$ | $PI_{1,1,s,1}$ | | | $O_{1,r,s}$ | $PI_{1,r,s,1}$ |
| | | ⋮ | | | | ⋮ |
| | | $PI_{1,1,s,t}$ | | | | $PI_{1,r,s,t}$ |
| ⋮ | | | | | | |
| BRANCH q | $O_{q,1,1}$ | $PI_{q,1,1,1}$ | | | $O_{q,r,1}$ | $PI_{q,r,1,1}$ |
| | | ⋮ | | | | ⋮ |
| | | $PI_{q,1,1,t}$ | | | | $PI_{q,r,1,t}$ |
| | ⋮ | | | | ⋮ | |
| | $O_{q,1,s}$ | $PI_{q,1,s,1}$ | | | $O_{q,r,s}$ | $PI_{q,r,s,1}$ |
| | | ⋮ | | | | ⋮ |
| | | $PI_{q,1,s,t}$ | | | | $PI_{q,r,s,t}$ |

$$\text{PRODUCTIVITY (BRANCH q)} = \frac{\sum_{i=1}^{r}\sum_{j=1}^{s}\sum_{k=1}^{t} PI_{q,i,j,k}/(r)(s)(t)}{\text{TOTAL INPUT (BRANCH q)}}$$

Fig. 3. Organizational Productivity Matrix Model

## Research Questions

In order to measure productivity, the following research questions must be answered.

1. What are the strategic level organizational goals of a base level USAF civil engineering organization?

2. What are the operational objectives of the branches, that direct activities toward achieving the goals defined in research question 1?

3. What existing recorded branch activity output and input data is available for developing performance indicators in terms of quantity, quality, timeliness and customer satisfaction, that support the objectives identified in research question 2?

# CHAPTER III

# FINDINGS

## Introduction

A review of existing USAF civil engineering policy guidance, functional directives, and sources of output and input data was conducted. The review included Executive Orders, Department of Defense directives and instructions, Air Force regulations, manuals and recurring periodicals, and forthcoming guidance from the Civil Engineering and Services Management Engineering Team and publications from the Air Force Institute of Technology Civil Engineering School. This chapter presents the pertinent information contained in the above publications which supported the development of the strategic level organizational goals and the branch objectives; and identified the available branch activity output and input information.

## Methodology

The methodology for this research was a secondary literature search. The researchers systematically reviewed available documented guidance pertaining to the three areas of interest specified in the research questions; i.e., (1) strategic level organizational goals, (2) branch objectives and (3) performance indicators.

The search for goal statements involved many different sources of information. No attempt was made to consolidate similar statements from different sources in this chapter. Because the directives, in most instances, have not attempted to differentiate between organizational level and branch level requirements in their presentation of requirements, the information on goals and objectives will be presented together in this chapter. Also, the thrust of the literature search for branch objectives was limited to statements of functional requirements and responsibilities.

The literature search for performance indicators was centered around actual output, input and performance data which is already being collected at base level within the civil engineering organization. The search did not include an attempt to identify desired output, the denominator for a performance indicator. Unless desired outputs are established by directive they should be locally developed by managers through a Management by Objective (MBO) program or other management technique (20:174).

Input data, as previously stated in Chapter II, are available from the Base Engineer Automated Management System (BEAMS) products and the Resource Management System (RMS) products. The level of detail provided by these systems, concerning inputs relative to activities and responsibility areas, was sufficient to allow concentration on output measurement.

Because the model for productivity measurement presented in Chapter II requires that the performance indicators be dependent upon the objectives which in turn are dependent upon the goals, no attempt was made to filter the data presented in the remaining sections of this chapter. The filtering and integration of data to provide explicit statements of strategic level organizational goals, branch level operational objectives and associated performance indicators will occur in Chapter IV.

## Goals and Objectives

The productivity model developed in Chapter II requires a goal/objective/performance indicator hierarchy. USAF civil engineering mission requirements and policy are primarily stated in Air Force regulations.

Interpretation of, or emphasis on, certain mission requirements also emanated from the office of the Director of Engineering and Services. Additionally, DOD directives and instructions are sources of general policy guidance underlying the more specific Air Force regulations, and often provide the essence or the philosophy that is to be reflected in the more specific Air Force regulations and policy.

The Air Force regulations pertaining to civil engineering specifically are found in the 85-X, 86-X, 87-X, 88-X, 89-X, 90-X, 91-X, 92-X and 93-X series publications.

These publications address areas concerning: general civil engineering requirements, programming, real property management, facility design and planning, facility construction, housing, real property operation and maintenance, fire protection, and special civil engineering programs.

Air Force Regulation (AFR) 85-10, Operation and Maintenance of Real Property (59), establishes the basic policy and responsibility for the base civil engineering organization. Figure 4 is the mission of civil engineering activities set forth in AFR 85-10. To expand this list of mission statements and to establish a basis for which a concise statement of base level USAF civil engineering strategic goals could be developed, Department of Defense and Air Force published policy directives that pertain to the basic mission requirements stated in AFR 85-10 were examined. A major concern for the acquisition, operation, maintenance and disposal of facilities was evident throughout the civil engineering policy statements. The proper utilization of these facilities, the total cost from conception to demolition, and the livability of the base facility community also received considerable attention. Finally, environmental impact and energy consumption related to the operation of the facilities was of major concern.

Major General Robert C. Thompson stated that

> . . . engineers must do more than build and maintain. They must insure that what is built satisfies the needs of our people. Our products must be

**1. Mission of Civil Engineering Activities.** The primary mission of civil engineering activities is to acquire, construct, maintain and operate real property facilities, and provide related management, engineering and other support work and services. Specifically base civil engineering activities are organized to:

a. Maintain in the most economical manner all active property (or structures furnished in lieu of real property) to a standard that prevents deterioration beyond that which results from normal wear and tear, and inactive facilities to a standard commensurate with reactivation requirements.

b. Conserve natural resources through efficient land and forestry management and environmental pollution control and abatement.

c. Provide fire prevention and protection engineering services to prevent loss of life and property at all installations.

d. Furnish refuse collection and disposal, custodial, and insect and rodent control (entomology) services efficiently and economically.

e. Furnish utility services required to accomplish assigned missions efficiently and economically.

f. Formulate and maintain a maintenance program that will accurately reflect the backlog of essential maintenance and repair.

g. Use contract services effectively to support or satisfy installation missions and requirements.

h. Accomplish alteration and minor new construction necessary to provide essential facilities needed in support of mission changes (or other circumstances) which preclude programming under normal construction budget procedures.

i. Provide management and professional engineering services to ensure the most effective and economical operation of all activities.

j. Support civil and airbase disasters and emergencies, using the personnel and material resources of civil engineering as necessary to save lives, mitigate human suffering, and to minimize damage (see AFM 355-1).

★ k. Provide forces to recover air bases damaged by natural disasters or enemy attack. If damage or disaster is beyond local capability, Prime BEEF assistance will be requested of the major command (see AFR 93-2, AFR 93-3, and AFM 93-6).

Fig. 4. Mission Requirements of Civil Engineering Activities [59:2]

> functional, they must look good, they must be maintainable and they should be something in which we all take pride [41:1].

AFR 89-1, Design and Construction Management, provides policies, procedures and responsibilities for the design and construction of Air Force facilities. This regulation states that the

> . . . design of facilities must:
> a) Be based on actual requirements of the project.
> b) Meet the operating requirements of the using activity and provide reasonable flexibility to accommodate foreseeable changes in requirements by the using activity. And,
> c) Provide highly functional facilities at the lowest practical construction costs, with due regard for energy conservation and economy in maintenance and operation of the facility [51:p.2-1].

Additionally, this regulation requires economic studies which

> . . . should consider the life cycle cost of the facility so as to arrive at an economical cost which considers not only the initial construction cost, but also operation and maintenance costs over the design life of the facility [51:p.2-3].

Department of Defense (DOD) Directive 4270.1, Construction Criteria, states that

> . . . military facilities shall be designed and constructed to meet the functional requirements they support. Construction criteria and policy guidance shall be based on function, durability, and reasonable, appropriate costs of maintenance and operation over the design life of the facilities [71:1].

Furthermore, AFM 88-15, Air Force Design Manual Criteria and Standards for Air Force Construction, establishes criteria and standards for the type and quality of materials and systems to be used in the construction of

Air Force facilities to ensure minimum maintenance and life cycle costs (45:p.1-1).

AFR 86-4, Master Planning, establishes the civil engineering responsibility for continually evaluating the adequacy of Air Force facilities. It also states that master plans must be prepared with the underlying principle that base facility arrangements should ultimately insure

a. Efficient and economical operations.
b. Efficient and economical use of existing real property resources. And
c. Provision for a good living and working environment [55:1].

AFM 86-1, Programming Civil Engineering Resources, states that the objective is to achieve and maintain a base where all facilities are real property condition code 1 (they can house the function for which designated with reasonable maintenance and without alteration or reconstruction) (63:p.1-1).

The concept of proper utilization of base facilities is addressed in several directives. DOD Directive 4165.20, Utilization and Retention of Real Property, states:

> Department of Defense real property, wherever located, shall be limited to the land area and the number and types of buildings and other improvements that are essential to the support of current missions and the forces. . . . All real property of whatever size, kind or nature not essential to such support shall be reported as excess [75:2].

AFR 87-2, Use of Real Property Facilities, sets forth policy to ensure maximum use of real property facilities (67:1). Additionally, AFM 86-2, Standard Facility Requirements,

was developed to provide guidance to realize the Air Force goal to,

> a. Make maximum use of existing facilities.
> b. Acquire and maintain through continuous study of functional requirements, solid justifications for building new facilities and occupying existing facilities.
> c. Insure that design criteria for new or revised functional requirements are available when needed.
> d. Achieve accuracy, completeness and uniformity in planning, programming, and budgeting for the operation, maintenance, and construction of needed facilities [65:p.1-1].

Finally, AFR 90-1, Assignment of Family Housing, (47:p.2-1) and AFR 90-6, Air Force Inventory and Utilization of Military Family Housing, (46:p.1-2) set forth policy concerning utilization of family housing, and set the goal of 99 percent occupancy rate for all family housing units.

Quality of life and the personal needs of the base facility users have also been included in the desire for proper utilization of facilities. This was summed up in Major General Robert C. Thompson's statement,

> We in Engineering and Services management should be giving far more attention to the quality of our product in terms of livability, aesthetics and functionality. This applies to all facilities including out-of-doors areas as well as the buildings and building interiors where people live, work, shop, and spend their leisure time. It also extends to all types of improvement projects, rehabilitation/revitalization, new construction and normal operations and maintenance [38:1].

The policy guidance previously presented indicated that the operations and maintenance actions and related costs should not be overlooked during facility design and construction. These costs are an important function in life

cycle costing and also affect the livability and functional use of base facilities. The following directives expand or reinforce the Air Force policy concerning operations and maintenance.

Major General William D. Gilbert, Director of Engineering and Services stated that the civil engineering mission has the world-wide requirement of maintaining and repairing Air Force facilities, and that the base level organization is the key to this maintenance program (13:80). He further stated:

> We have made great strides in the last few years to improve the appearance and livability of our facilities. Of equal importance is the maintenance and repair of vital utility systems and facilities which must be dependable and ready to support mission requirements [13:80].

Operation and maintenance policy for family housing is contained in DOD Instruction 4270.21, Policy and Criteria of Operating, Maintenance and Repair of Defense Family Housing, and AFR 91-1, Operation and Maintenance of Air Force Family Housing. DOD Instruction 4270.21 states,

> Family housing facilities shall be operated and maintained to a standard which will provide decent and livable accommodations in good condition and protect the facilities from deterioration [73:2].

AFR 91-1 states that the objectives of the Air Force family housing operations and maintenance program are:

> (1) Provide livable accommodations in good condition.
> (2) Protecting family housing facilities from deterioration.

(3) Ensuring effective and efficient accomplishment of O&M activities.
and
(4) Ensuring that extreme care and judgement are used in maintaining, renovating, and altering facilities of national historic interest in order to preserve their historical significance [57:1].

The maintenance policy guidance is extended to include custodial services as set forth in AFR 91-30, Custodial Service. This regulation states that, "It is Air Force policy to . . . provide custodial service as a part of its building operations and maintenance function . . . [50:1]." The principle behind custodial service policy is as follows:

> Custodial service performed in a timely manner, using prescribed supplies and methods, is necessary for the maintenance of desirable standards of health and morale and for the preservation of buildings [50:1].

Another aspect of preventive maintenance that has received considerable attention is corrosion control. AFR 91-27, Corrosion Control, establishes civil engineering responsibilities and policies concerning this aspect of maintenance. AFR 91-27 states that the objective is "to sustain a high degree of operational systems; conserve resources; and reduce costs [49:1]."

As stated previously, facility design, construction, operations and maintenance, and proper utilization are areas of concern addressed in much of the policy guidance for USAF civil engineering organizations. With the additional consideration for life cycle costing and minimum use of

resources, the subject of disposal of unwanted or unneeded facilities, or those beyond economical repair has also affected policy considerations. AFR 87-4, Disposal of Real Property, sets forth guidance and policy for the timely disposal of Air Force real property (53:2).

Another area of USAF civil engineering policy and responsibilities is concerned with protection of facilities and human beings from fire, weather, natural disasters, wartime destruction, pests, and operational hazards. The previous review of facility design and construction standards included policy statements concerning these considerations. Additional specific guidance is found in several Department of Defense and Air Force sources.

AFR 92-1, Fire Protection Program, establishes the policy and responsibilities for base level civil engineering organizations, concerning fire engineering, fire protection, fire-fighting and rescue operations (54). This policy was summarized in an article by Lieutenant Colonel Anthony M. Vilale, in which he stated,

> The Base Civil Engineer (BCE) bears the responsibility for providing adequate protection for facilities on his installation. The responsibility involves incurring safe construction through engineering, the selection of proper building materials, providing installed protection, adequate utilities and maintenance of a fire department. The BCE must also keep facility occupants informed of fire prevention practices and procedures encumbent upon them [77:9].

AFR 93-2, Disaster Preparedness and Base Recovery Planning, establishes the base civil engineering

responsibilities for smoothly and rapidly converting to an emergency response effort. The regulation states that,

> The base civil engineer will:
> a. Establish a recovery program and maintain BCE base recovery plan to save lives, mitigate human suffering, and minimize damage during and after a disaster occurring on or near his installation.
> b. Provide trained forces, equipment, and material to return the base to operational readiness in the shortest possible time following a disaster. . . [52:1].

Air Force installations geographically located where snowfall occurs can experience mission degradation, facility damage, and unsafe conditions resulting from adverse weather. Air Force policy for civil engineering snow removal operations is contained in AFM 91-14, Airfield and Base Snow and Ice Removal and Control. This regulation states that, "Compliance is necessary to provide safe operating ground surfaces for aircraft and ground vehicle traffic during winter operations [44:p.1-1]." And responsibilities for snow and ice removal and control are necessary, "to minimize restriction of mission capability. It includes the safeguard of property against damage during snow removal operations [44:p.1-1]."

Accident prevention safety, and occupational health requirements are established in DOD Directive 1000.3, Accident Prevention, Safety, and Occupational Health Policy for the Department of Defense. This directive states that,

> Accident prevention, safety, and occupational health programs designed to (a) prevent employee injury

> and occupational illness, and (b) protect federal equipment, material, and facilities from damage or loss, shall be developed. . . [70:2].

AFR 89-1 states that

> All designers of Air Force construction projects must produce drawings and specifications which are consistent with the standards issued by the Secretary of Labor under the Williams-Steiger Occupational Safety and Health Act [51:p.2-6].

DOD Directive 4150.7, Department of Defense Pest Management Program, establishes policy and standards for pest control. This directive sets the standards for

> . . . the safe and efficient management of disease vectors and animal and plant pests on DoD Installations which (a) affect health and welfare of humans; (b) damage property; or (c) cause injurious environmental imbalance [72:p.1-2].

AFM 91-16, Military Entomology Handbook, states that,

> The control of insects, rodents, and other pests is an essential service that should have high priority for combating disease, maintaining morale and efficiency and preventing property losses [56:p.1-1].

AFR 91-21, Pest Management Program, establishes policies and responsibilities for base civil engineering organizations. The essence of the policy is to protect humans and prevent damage to facilities (60:1).

Another important aspect of base civil engineering responsibility is that of providing adequate utilities for installation activities and systems, yet overconsumption or waste of utilities or energy is also a concern. AFR 91-5, Utilities Services, establishes responsibility and policy for providing electric, water, sewage disposal, gas,

solid wastes collection and disposal, heating, and community antenna television service (68). AFM 91-12, Policies, Procedures, and Criteria for the Management and Conservation of Utilities, establishes the following conservation policy,

> The objectives of this program are to insure that:
> (1) Utilities are provided and used without waste.
> (2) Utilities plants and systems are operated efficiently and economically.
> and
> (3) Personnel are made aware of the importance of utilities and the need for limiting use of actual requirements [61:p.2-1].

Air Force facility energy policy is based upon Executive Order 12003, Relating to Energy Policy and Conservation, which stated in part:

> . . . each agency to the maximum extent practicable aims to achieve the following goals:
> (1) For the total of all Federally-owned existing buildings the goal shall be a reduction of 20 percent in the average annual energy use per gross square foot of floor area in 1985 from the average energy use per gross square foot of floor area in 1975. . . .
> (2) For the total of all Federally-owned new buildings the goal shall be a reduction of 45 percent in the average annual energy requirement per gross square foot of floor area in 1985 from the average annual energy use per gross square foot of floor area in 1975 [42:2.B.3].

The order continued ". . . each agency shall program its proposed energy conservation improvements of buildings so as to give the highest priority to the most cost-effective projects [42:2.B.5]." And, finally, prohibited the lease of any new facility which will not likely meet the 45 percent reduction standard (42:2.B.5).

Guidance for all Air Force from the Department of Defense for facility energy planning comes primarily from three Defense Energy Program Policy Memorandum (DEPPM) numbered 78-2, 78-8 and 79-1. These DEPPMs established four levels of priority for DOD energy management during 1979, established guidelines for DOD participation with the Department of Energy on energy technology and listed goals and objectives and the time frame for their accomplishment. These goals include:

1. Achieve the 20 percent reduction in facility energy consumption by a 12 percent reduction through ECIP (Energy Conservation Investment Program) and 8 percent through operations and maintenance efforts.

2. Establish a metering program and to conduct energy audits and surveys.

3. Obtain at least 10 percent of DOD installation energy from coal, coal gasification, solid waste, refuse derived fuel and biomass.

4. Obtain 1 percent of DOD installation energy from solar and geothermal means.

5. Equip natural gas only heating units and plants that have a capacity of more than five mega BTUs with an alternate fuel capability.

6. Have a thirty-day supply of fuel on hand for all five mega BTU heating units and plants that are oil only, oil and natural gas and coal powered, and maintain that

reserve for the three coldest months of the year (42:2.C.1-2.C.19).

Air Force energy objectives have been consolidated and presented for Air Force Energy Management Division in the U.S. Air Force Energy Plan 1978. These objectives were:

> Maintain energy consumption for all activities at the lowest possible level consistent with mission requirements and operational readiness.
>
> Demonstrate the use of alternate fuels for aircraft and base operations and eventually establish a multi-fuel capability for all Air Force systems.
>
> Review operational and training procedures to insure that more plentiful energy sources are substituted for rapidly depleting resources where feasible.
>
> Cooperate with federal agencies in the demonstration and application of new energy technologies.
>
> Apply the principle of "energy effectiveness" to future engineering developments and systems acquisitions in terms of return on investment or life-cycle costs [37:2].

The Air Force Ten-Year Facility Energy Plan defined Air Force facility energy as "energy used for heating, ventilation, air conditioning, or lighting of fixed Air Force facilities for personnel comfort or building protection [43:2]." The plan further defined Engineering and Services related process energy as "airfield lighting, street lighting, water, and sewage distribution systems and plants, etc. [43:2]." In addition to the goals established by the Department of Defense, the plan identified long-term energy goals to reduce energy consumption further by the year 2000, to further reduce the reliance on petroleum for energy, to increase advanced energy technology use and research, and

identified facility classes for energy consumption reductions (43:9-37).

Air Force environmental policy is based upon Executive Order 12088, Federal Compliance with Pollution Control Standards. This Executive Order requires compliance with all federal, state and local laws and regulations pertaining to pollution control. If it is found that a government agency is in violation of an applicable pollution control standard, the agency must respond with a plan to achieve and maintain compliance and an implementation schedule (6).

DOD Directive 5100.50, Protection and Enhancement of Environmental Quality, states that DOD activities must recognize that they have an impact on the environment, and that the activities must comply with the spirit and the letter of the National Environmental Policy Act and other Federal environmental laws, regulations and executive orders. The directive also requires activities to demonstrate leadership in environmental pollution abatement and enhancement of the environment (74:2).

Air Force policy on environmental protection is set forth in AFR 19-1, Pollution Abatement and Environmental Quality. To executive and DOD policy, AFR 19-1 adds:

1. Supporting pollution abatement programs of local communities.

2. Starting analysis of environmental consequences of the earliest practicable stage.

3. Protecting the human environment in the areas of air, water, noise, pesticide management, and solid waste management.

4. Insuring that facilities outside the United States comply with host nation requirements.

5. Develop contingency plans and procedures for dealing with accidental pollution incidents (62:2).

Environmental goals and policy at the base level are highly dependent upon state and local laws which affect the base.

The wartime USAF civil engineering requirements differ from the peacetime requirements. Major General Robert C. Thompson, former Director of Engineering and Services, Headquarters USAF, posed the question,

> Are we in Air Force Engineering and Services ready to fully perform our wartime duties in support of the Air Force mission? . . . If we cannot answer "yes" to the question . . . nothing else we do is of much importance [39:2].

AFR 93-3, The Prime BEEF Program (66), and AFM 93-6, Operation and Maintenance of Prime BEEF (58), set forth the policy for base civil engineering to provide military personnel postured, equipped, and trained to perform direct combat support functions and react to local and worldwide emergencies. The goal of readiness is captured in an article by Lieutenant Colonel O. F. Smith, where he stated that:

> Our active, reserve and civilian force must, in its day-to-day posture, be highly trained, equipped and motivated, truly a lean and mean outfit. We call this Readiness--everyone with a wartime job, specifically pointed at and tasked to do a certain function whether the conflict be conventional or nuclear [33:4].

The preceding paragraphs have reviewed the current policy guidance concerning base level civil engineering organizations. Our intent is to assimilate this information into a concise set of strategic level organizational goals to fit within the structure of the productivity measurement model developed in Chapter II. The requirement for developing specific subgoals or objectives for branches within the civil engineering organization now needs to be addressed.

Functional requirements of the civil engineering branches are stated in AFR 85-10 and Figure 5 lists these functional requirements of civil engineering activities.

## Performance Indicators

Base level civil engineering organization managers have two primary sources of information concerning output and input data. The first source of data is that recorded for developing the Commander's Update Briefing which is required by AFR 85-1 (64). The second source of data is the Base Engineer Automated Management System (BEAMS) products, developed as specified in AFM 171-200, Vol. II (48). The first source contains primarily output data while the second source contains both output and input data.

**2. Functions of Civil Engineering Activities.** Detailed procedures on these specific functions are given in other Air Force publications (see publications in the 30, 35, 85 through 93, and the 126 series).

a. Management of Air Force real estate:

(1) Determines and performs Air Force responsibilities in the acquisition for base use of fee title, leasehold, and lesser interests in land and the programmed disposal of land and improvements.

(2) Issures appropriate utilization of buildings and real property facilities.

(3) Controls outgrants and establishes rental rates for military family housing and other facilities occupied on a rental basis.

(4) Establishes and maintains the real property accountable record, including the preparation, validation and submission of inventory, installation characteristics, and related reports.

b. Planning and programming:

(1) Establishes and maintains facility requirements needed to accomplish the installation mission.

(2) Develops programming documents for the construction, maintenance, and repair of real property facilities.

(3) Develops and performs status reporting and control of related projects.

c. Engineering and construction. Manages and supervises construction and related programs; accepts real property constructed for the Air Force; and provides professional engineering service for:

(1) Design and inspection of maintenance, repair, and construction contracts.

(2) Traffic planning and geometric design of streets, highways, and abutting lands, with attendant controls, to provide safe and economical transportation of persons and materials.

(3) Utility rate studies, selection of architectural and engineering firms, economic and engineering cost studies, and corrosion surveys.

d. Utility services:

(1) Provides basic utility services in the most economic manner commensurate with the needs of using activities.

(2) Establishes requirements for the most economical production and distribution of utilities (water, electricity, gas) as well as the operation of other utility systems (for example, heating, cooling or air-conditioning, waste water, ice manufacturing, and cold storage refrigeration systems); satisfies these requirements either by contract or in-service capability. In addition, performs technical surveillance of contractor performance when these services are provided by contract.

(3) Determines fuel requirements, provides quality and corrosion control services and complies with environmental and pollution control requirements in providing these utility services.

Fig. 5. Functional Requirements of Civil Engineering Activities [59:2-3]

(4) These functions do not include responsibility for the use of refrigerated space nor for the storage and distribution of ice.

e. Maintenance and repair of structures and equipment. Identifies and performs maintenance and repair incident to maintenance on:

(1) Facilities and structures (for example, buildings, pavements, and electronic supporting structures classified as real property), and real property installed equipment (RPIE).

(2) Government-furnished domestic appliances that are a part of public quarters, officers quarters, airman dormitories, or comparable facilities, whether or not the equipment is classified as RPIE or organizational equipment.

(3) Electric-powered or installed food service equipment.

(4) Equipment required to satisfy facility criteria and functional requirements in a particular building.

(5) Traffic control devices and aircraft arresting systems.

(6) Equipment authorization inventory data (EAID) war readiness material (WRM) and other equipment or supply items furnished, or used, in lieu of real property facilities.

f. Training aids. Fabrication, minor construction, maintenance, and repair of training aids used to support:

(1) Target ranges and obstacle courses.

(2) Air-to-ground and ground-to-air ranges and other ranges.

(3) Small arms training (for example, target frames, observation towers and similar facilities classified as real property). NOTE: The operation of these aids and facilities is not a civil engineering function.

g. Services. Planning, scheduling, and performing custodial services, snow removal, refuse collection and disposal, entomology, and other services.

h. Fire protection. Development, management and execution of programs for fire protection, including all aspects of fire protection engineering, fire prevention and suppression, and related aerospace vehicle standby and personnel rescue operations.

i. Family Housing Management. Supervises, coordinates, and accomplishes responsibilities associated with:

(1) Utilization of military family housing assets including assignments, terminations, inquiries, interviews and related administrative work (see AFM 30-6).

(2) Planning, programming, and budgeting for maintenance, repair, alteration, and new construction that apply to military family housing.

(3) Change of occupancy inspections.

(4) Housing referral services.

Fig. 5--Continued

Guidance for the content of the Commander's Update Briefing is being developed by both the Air Force Institute of Technology, Civil Engineering School (AFIT/DE), and the Civil Engineering and Services Management Engineering Team (CESMET). Drafts of the proposals were reviewed for output and input data.

The information extracted from the AFIT/DE proposal (2) is presented in Table 1 and the information from the CESMET proposal (7) is presented in Table 2. The output and input data presented in Tables 1 through 3 have been numbered consecutively for ease of reference. A list of abbreviations used in the tables precedes them.

AFM 171-200, Vol. II, Base Engineer Automated Management System (BEAMS), states that the purpose of BEAMS is,

> (1) to provide information to BCE personnel to more efficiently and effectively manage resources, and (2) to provide, through minimum base effort, reports required by higher headquarters and the Congress [48: p.2-1].

The data contained in the BEAMS system is the result of the integration of data from several BCE activities into a common data base (48:p.2-1). The BEAMS system is composed of nine subsystems which are: Labor and Prime BEEF; Work Control; Cost Accounting; Material Processing; Real Property; Maintenance, Repair and Minor Construction Program; Recurring Maintenance; Pesticide Evaluation Summary Tabulation; and Pavement Condition Indices. The Executive

Management Summary is an automated analysis taken from a cross-section of the BEAMS data based in the nine sub-systems.

Standard computer products are made available to specific base civil engineering managers on a recurring basis in accordance with AFM 171-200. Table 3 summarizes the output and input information available through the specific products.

List of Abbreviations Pertaining to Tables 1, 2, and 3

BCE - Base Civil Engineering

BLDG - Building

BMAR - Backlog of Maintenance and Repair Work

COCESS - Contractor Operated Civil Engineering Service Store

EEIC - Element of Expense Investment Code

FY - Fiscal Year

MAREMIC - Maintenance, Repair and Minor Construction Program

MAS - Maintenance Action Sheet

MC - Minor Construction

MCP - Military Construction Program

MFH - Military Family Housing

MRL - Material Requirements Listing

M&R - Maintenance and Repair

NAF - Non-Appropriated Funds

NR - Number

O&M - Operations and Maintenance

PCI - Pavement Condition Index

RMP - Recurring Maintenance Program

SF - Square Feet

TABLE 1

SUMMARY OF COMMANDER'S UPDATE BRIEFING DATA (AFIT/DE)

| Nr. | Title | Data Summary |
|---|---|---|
| 1 | Status of special interest work | - |
| 2 | Number of emergency job orders received and number accomplished within 48 hours | - |
| 3 | Number of urgent job orders received and number accomplished within 5 days | - |
| 4 | Number of routine job orders received | - |
| 5 | Percent of routine job orders not completed within 30 days of date all materials are available | - |
| 6 | Recurring maintenance program | Scheduled and accomplished as scheduled |
| 7 | Accomplishment of operations services activities | - |
| 8 | Generator status | - |
| 9 | Work order planning backlog | Approved and planned |
| 10 | Waiting time for work requests and work orders | |
| 11 | Percent of manhour variance for work orders (absolute) | - |
| 12 | Facilities surveyed | - |

TABLE 1--Continued

| Nr. | Title | Data Summary |
|---|---|---|
| 13 | Facility Projects Program | - |
| 14 | Military Family Housing year to date occupancy rate | - |
| 15 | Military Family Housing monthly turnaround times | Total and maintenance |
| 16 | Holding area inventory balance | - |
| 17 | Bench stock fill rate | - |
| 18 | Vehicle out-of-commission rates | Base and CE |
| 19 | Vehicle status | - |
| 20 | Fire department crash rescue vehicles in-commission rate | - |
| 21 | Funds status | - |
| 22 | Cumulative funds expended, budgeted, actual and prior year actual | - |
| 23 | Military and civilian manpower projection | - |
| 24 | Prime BEEF team capability | - |
| 25 | Service contract evaluation | - |
| 26 | Fire department training status | - |

TABLE 1--Continued

| Nr. | Title | Data Summary |
|---|---|---|
| 27 | Fire department evaluation of last exercise | - |
| 28 | Fire department responses | - |
| 29 | Fire department inspection summary | - |
| 30 | AF Form 1255 summary | - |

TABLE 2

SUMMARY OF COMMANDER'S UPDATE BRIEFING DATA (CESMET)

| Nr. | Title | Data Summary |
|---|---|---|
| 31 | Prime BEEF readiness | Limitations, status and exercise dates |
| 32 | Fire department | Manning, vehicles, responses and training |
| 33 | Personnel | Authorized and assigned |
| 34 | O&M fund status by EEIC | - |
| 35 | Military Family Housing | 722 funding by EEIC |
| 36 | Military Family Housing | 721 funding by EEIC |
| 37 | Bench stock expenditure | Estimated and actual |
| 38 | Material expenditure/due outs (not including bench stock) | Estimated and actual |
| 39 | Material in the holding area | Number of job and work orders and dollar value |
| 40 | Material in the residual area | Inventory and used |
| 41 | Status of emergency/standby items | Number of line items required and dollar value |
| 42 | Vehicle status | - |
| 43 | Vehicle shortages | - |

TABLE 2--Continued

| Nr. | Title | Data Summary |
|---|---|---|
| 44 | Projects in procurement | - |
| 45 | Manpower availability/utilization | Percent direct labor by LUC |
| 46 | Direct scheduled work | Received and complete |
| 47 | Last week's schedule | Progress by work order |
| 48 | Schedule deviation | Reason by shop |
| 49 | This week's schedule | Problems by work order |
| 50 | Next week's schedule | Problems by work order |
| 51 | SMART schedule | - |
| 52 | Job stoppage | Status by work order |
| 53 | IWP compliance | Missed completions, reason by work order |
| 54 | Work order backlog | Number of months by shop |
| 55 | Planning backlog | Number by type |
| 56 | Minor construction limitation | Percent of direct manhours by shop |
| 57 | Bench stock availability | Number of line items by shop |
| 58 | Material status | By work order for current and first future month |

TABLE 2--<u>Continued</u>

| Nr. | Title | Data Summary |
|---|---|---|
| 59 | Material response time | Percent of total by 30-day intervals |
| 60 | Supply support problems | By work order and job order |
| 61 | COCESS performance | - |
| 62 | Customer evaluation program | Return rate |
| 63 | Customer evaluation program | Evaluation by shop |
| 64 | BCE taxi utilization | Average number of trips per taxi per day by day |
| 65 | Design plan | Dollar value, number and status of projects by program for past and current year |
| 66 | Command interest items | Status by item |
| 67 | Fire department | Status of deficiencies and inspections |
| 68 | Military family housing occupancy rate | By month |
| 69 | Military family housing U-Fix-It Store | Number of customers by shop; service calls, manhours and dollars saved |
| 70 | Management by Objective status by Objective | - |
| 71 | Industrial engineering studies status by purpose | - |

TABLE 3

SUMMARY OF BEAMS PRODUCTS

| Nr. | Title | Data Summary | |
|---|---|---|---|
| 72 | Civil Engineer Cost Report | Civilian and military manhours, labor $, project $, service contract $, material $, other $, total $, unit cost, (hi or lo) comparison - by cost account code | |
| 73 | Family Housing Cost Report | Same as 72, except for family housing only | |
| 74 | Pest Summary Report | Pest name, operation name, area treated, bldg/terrain, pesticide, form, quantity, supply source, manhour survey, labor/supervisor hours, total acres, total bldg SF | |
| 75 | MAREMIC Detail Transaction Report | - | |
| 76 | Inventory Changes During Fiscal Year | Part I | Land area/cost |
| | | Part II | Improvements |
| | | Part III | Cost of new construction (MCP, MC, O&M, NAF) |
| 77 | Recurring Maintenance Schedule Parts I and II | Part I (current week) | Facility NR, cost center, equipment, MAS NR., location, criticality, labor hours, work order NR., overdue<br>Total hours for facility and cost center |
| | | Part II (next week) | Same as above |

TABLE 3--Continued

| Nr. | Title | Data Summary |
|---|---|---|
| 78 | Recurring Maintenance Man-Hour Comparison Report | Facility NR., frequency, MAS NR., equipment cost center, size/capacity, standard hours, actual hours, % of variance, selection % |
| 79 | Cost Comparison Report | Recurring maintenance<br>Facility NR., equipment, cost center, equipment description, original cost, date installed, criticality, frequency, life expectancy (years), cumulation maintenance cost, average annual cost<br>Current fiscal year cost; total, % standard |
| 80 | RMP Low Cost Record Purge Report | Original equipment cost < $800<br>Cost center, equipment description, facility NR., date installed, 1st and 2nd preceding fiscal years' maintenance cost, original cost, criticality |
| 81 | Real Property Work Order Capitalization List | Work order NR., date closed out, facility NR. |
| 82 | Real Property Control Ledger | Asset account NR. to cost account code<br>Real property record cost to date |
| 83 | Real Property Voucher Transaction Summary by Facility | Voucher NR., category code, description of action, area change, total area, value change, cost to government - by facility NR. |
| 84 | Facility Cost Account Cross-Reference List | Facility NR., disposal fiscal year, condition code, nomenclature, category-code, area, last inventory date |

TABLE 3--Continued

| Nr. | Title | Data Summary |
|---|---|---|
| 85 | Real Property Space Summary by Condition | Facility NR., usable class A & B, in-use replace or conversion required, sterile, unusable - by category code |
| 86 | Facility Vacant Area Inquiry by Installation | Facility NR., category code, vacant area |
| 87 | Selected Inquiry by Organization Assigned | Facility NR., category code, nomenclature area - by organization code |
| 88 | Real Property Inventory by Selected Category Code | Facility NR., permanent/semi/temporary, condition-code, description, vacant area, total area, rent $, cost, estimated value, year constructed - by category code |
| 89 | USAF Real Property Inventory Detail List | Facility NR., condition code, permanent/semi/temporary, category code, vacant area, total area, cost, year constructed - by facility NR. |
| 90 | BCE Weekly Schedule Report | Current week and year to date - Estimate labor hours, actual labor hours - by type work & cost center Direct labor - estimated/actual total direct, estimated/actual by type, % type work/total direct |
| | | Indirect labor - estimated/actual total direct and indirect, estimated/actual total direct and indirect by type, % type work/total direct + indirect |
| | | % minor construction/total direct, availability rate |

TABLE 3--Continued

| Nr. | Title | Data Summary |
|---|---|---|
| 91 | BCE Monthly In-service Work Plan Report | Same as #90 only current month, current quarter and year to date loaned/borrowed labor |
| 92 | Monthly Labor Augmentation Report | Part I Cost center, loans, borrows, net military and civilian overtime for prior month and fiscal year to date<br>Part II Consolidated Part I by cost center |
| 93 | BCE Prime BEEF Detail Listing | Military personnel authorized, required, assigned<br>Civilian personnel authorized, required, assigned |
| 94 | Base Prime BEEF Listing by Team | Same as #93 only by team |
| 95 | BCE Work Stoppage Report | Work class, priority, date start, date last hours received, % actual/estimate - by work order NR. |
| 96 | BCE Work Authorization Work Order Purge List | Completed work orders awaiting close-out, NR. days waiting |
| 97 | BCE Material Due-in Listing | Part NR., supply $, COCESS $, total $ - by work order NR. |
| 98 | BCE Completed Work Order Cost Report | Work order NR., class, facility NR., organization code, estimated start and completion dates, actual start and completion dates, $ funded and unfunded - by cost center<br>Estimated funded $/actual $, estimated unfunded $/actual $, total estimated $/actual $ |

TABLE 3--Continued

| Nr. | Title | Data Summary |
|---|---|---|
| 99 | BCE Using Organization Work Order Listing | Work order NR., class, priority, facility NR., estimated $, estimated start date, method - by organization code |
| 100 | BCE Work Order Backlog Report | Part 1A - work orders exceeded estimated start date<br>Part 1B - by month<br>Part 1C - months backlog by cost center for 12 months months minor construction backlog by cost center for 12 months<br>Part 2A - location of work order/status<br>Part 2B - same as part 1C by location or work order<br>Part 3 - total backlog by work order NR.<br>Part 3B - by month for 12 months |
| 101 | BCE Completed Collection Work Order Cost Report | For fiscal year - cost center, labor hours, shop rate $, project $, service contract $, materials $, funded/unfunded |
| 102 | BCE Cost Limitation Comparison Listing | Part I MFH - by work class (MC or M&R)<br>Part II BASE - approved $ level/actual $ to date<br>Part III ALL - MAJCOM or higher approved work orders 80% of approved $ |
| 103 | Civil Engineer Cost Report (Part I) | Civilian and military labor hours, total $, project $, service contract $, material $, other $, unit cost, (hi or lo) comparison - by cost account code |
| 104 | Family Housing Cost Report (Part II) | Same as #103 but MFH only |

TABLE 3--Continued

| Nr. | Title | Data Summary |
|---|---|---|
| 105 | Family Housing Cost Report (Part III) | Construction report<br>$ design, $ construction, $ inspection, civilian and military labor, $ labor, project $, service contract $, material $, other $, total $ |
| 106 | BCE Current Month Cost Report | Same as #103 only for current month |
| 107 | MFH Current Month Cost Report | Same as #104 only for current month |
| 108 | BCE Material Transaction List | Daily accepted, rejected, or suspended supply transactions and COCESS transactions |
| 109 | COCESS Funds Status | % issues/due outs, total $ expense year to date, balance current year COCESS funds, prior year balance |
| 110 | Shop Rate Analysis Report-Cost Center Summary | Civilian $, military $, material $, vehicle $, shop overhead $, available direct manhours, availability rate, direct material cost, material/manhour ratio - by cost center by month |
| 111 | Shop Rate Analysis Report - Category Summary | Effective shop rate<br>Actual costs - by cost center |
| 112 | COCESS Item Consumption Summary | Consumption NR. for current month and cumulating year to date - by MRL NR. |

TABLE 3--Continued

| Nr. | Title | Data Summary |
|---|---|---|
| 113 | COCESS Analysis Report | Effectiveness report - bench stock and other - by commodity group; total required, receipts - shelf, 48 hours, 3-10 days, >10 days, average pipeline time, non-price listed demands, price listed demands, fixed price demands, random demands |
| 114 | Pavement Condition Index Report | PCI of pavement areas - by sample NR. Date survey, NR. of samples |
| 115 | Month of Award Listing | Same as #122 by month of award |
| 116 | Current FY Program FY-XX | Project NR., description, category code, cost, design date, contract $ by date, command priority - by EEIC Totals of all EEIC's |
| 117 | Prior FY Program | Same format as #116 plus expenses and fiscal year |
| 118 | Unfunded Validated Requirements - Detail Listing | Same as #116 plus base priority and facility NR. |
| 119 | Unfunded Validated Requirements - Excluding Family Housing | BMAR $1K-$10K, BMAR >$10K, M&R delayed, M&R future, M&R other; M&R total; MC total - by O&M and NAF for current fiscal year |
| 120 | Unfunded Validated Requirements - Military Family Housing | Deferred and future projects - by type of housing, fiscal year, and EEIC |

TABLE 3--Continued

| Nr. | Title | Data Summary |
|---|---|---|
| 121 | CFY Program and Unfunded Requirements Priority Listing | Project NR., EEIC, description, category code, cost, obligation authority, decision date, contract $ and date, construction start and completion dates, percent complete, command and base priority, facility NR. |
| 122 | Base Verification Listing | Consolidated total MAREMIC program |
| 123 | Recurring Maintenance Reserved Manhours | Reserved cost center manhours - by month Totals - by cost center |
| 124 | Work Control Executive Management Summary | Data extracted from other reports, summarized |
| 125 | Cost Accounting Executive Management Summary | Data extracted from other reports, summarized |
| 126 | Labor Executive Management Summary | Data extracted from other reports, summarized |
| 127 | Material Control Executive Management Summary | Data extracted from other reports, summarized |
| 128 | Recurring Maintenance Executive Management Summary | Data extracted from other reports, summarized |

# CHAPTER IV

# ANALYSIS

## Introduction

The productivity measurement model developed in Chapter II focuses on outputs in terms of performance realized from a given level of resources consumed. The model is structured around a framework of strategic level organizational goals and the supporting branch level objectives or subgoals that address areas of key outputs contributing to the attainment of the goals. As stated previously, the model focuses on strategic level organizational goals not on: (1) internal organizational goals, such as training, work safety, and inventory control; (2) individual participant goals; (3) external users goals; or (4) base command goals. These goals are depicted in Figure 3 as inputs to the higher level policy-making functions establishing base civil engineering mission requirements and responsibilities, organizational structure and manning authorizations. Therefore, historical and forecasted external requirements are assumed to be incorporated into USAF Engineering and Services policy decisions. Further, "customer satisfaction" should not be specifically stated as a strategic level organizational goal in the model,

but should be considered as an influence on the development of the various strategic level organizational goals. Actual demands from the customers are processed within the constraints imposed by prior decisions concerning BCE organizational structure, responsibilities and resources. Therefore, customers' desired results for specific demands compared with actual results of BCE activities can be used to assess "customer satisfaction."

Once the strategic level organizational goals and supporting branch objectives are developed, the model still requires specific performance indicators directly related to each objective. As defined in Chapter II, performance indicators are ratios of actual outputs divided by desired outputs. The performance indicators must be valid indicators of key results contributing to the attainment of the branch objectives in terms of quality, quantity, timeliness and "customer satisfaction." Additionally, the model requires that the average of the performance indicators for each branch objective be divided by the resources consumed to achieve the results supporting the objective during a specified period of time. The resulting ratio of performance achieved to resources consumed will be the productivity index for that branch's efforts to support an objective during that specified time period. Finally, the series of productivity indexes may be compared over time

as an indicator to managers of the change in the organizational productivity.

The purpose of this chapter is to analyze the information gathered concerning strategic level civil engineering organizational goals, objectives, and performance indicators. First, the goals will be developed, by synthesizing the policy guidance presented in Chapter III. After establishment of the goal structure, specific branch objectives will be developed. Again, the development of objectives will be based upon the information presented in Chapter III pertaining to branch level functional responsibilities. Finally, the branch level activity output and performance information currently available to base civil engineering managers, as presented in Chapter III, will be evaluated.

## Goal Development

As stated in previous chapters, goals represent the desired future conditions that an organization tries to achieve. They include missions, purposes and objectives. Goals tend to focus the participants on relevant organizational processes, output or actions, and strategic level goals tend to relate the organization to its environment. Strategic level goals are useful to an organization because they provide direction and purpose, and an aspiration level accompanies them. The goals are usually very general and

are not directly operational or measurable and must be translated into objectives at the coordinating or operational level (20:155-164).

> A goal is a statement of intended output in the broadest terms. It is normally not related to a specific time period. Goals normally are not quantified, and hence cannot be used directly as a basis for a measurement system. The purpose of a statement of goals is to communicate top management's decisions about the aims and relative priorities of the organization, and to provide general guidance as to the strategy that the organization is expected to follow [3:133-134].

Therefore, a statement of USAF civil engineering goals from the base organizational strategic viewpoint should summarize the main purpose or mission of the organization. Additionally, the goals should focus on desired conditions not on civil engineering activities.

In Chapter III several sources of information concerning base civil engineering mission and purpose were reviewed. The primary source was AFR 85-10. The other sources of policy guidance either gave background for the mission and purpose or emphasized in more detail specific mission areas addressed in AFR 85-10.

Additionally, the main activities of a base level civil engineering organization relating to its mission or purpose are outlined in AFR 85-10 (see Figure 4). The development of the strategic level organization goals was accomplished by consolidating the statements of desired conditions presented in the different sources and the implied desired conditions resulting from the statements of

civil engineering activities. Redundancies between the sources were eliminated while retaining the mission concepts. Our intent was to capture the essence of the individual statements of purpose or mission from the various sources, focus on desired future conditions rather than activities, and to consider resource limitations. The results of our efforts are presented in Table 4.

For the purpose of the goals, objectives and performance indicators, the following definitions will apply:

1. Facility--all real property and real property installed equipment (RPIE).

2. Maintenance--all actions taken to keep facilities in operable, usable or acceptable condition. This includes snow removal, grass cutting, and building and road maintenance.

3. Repair--all actions taken to return facilities to operable, usable or acceptable condition.

## Objective Development

The strategic level organizational goal statements provide direction and guidance for organizational activities but they must be translated into more specific objectives or subgoals for the base level civil engineering branches. These objectives should not be confused with those typically associated with Management by Objectives (MBO) programs. The objectives for MBO are developed

## TABLE 4

### THE STRATEGIC LEVEL GOALS OF A BASE LEVEL USAF CIVIL ENGINEERING ORGANIZATION

1. Facility Life Cycle Costs: Ensure new facilities, additions, and alterations are designed and constructed in compliance with applicable building codes; and existing facilities are maintained and repaired at minimum cost throughout their lives, to allow for functional use, efficient operations, and minimum downtime; and are retired or replaced in a timely manner to provide the lowest possible life cycle cost.

2. Facility Function: Ensure new facilities are functionally designed and properly located for their programmed purpose; and existing facilities are properly assigned to mission functions, additioned, altered, maintained, repaired or replaced to provide continuous functional use.

3. Facility Protection: Ensure new facilities, additions, and alterations are designed and constructed in compliance with applicable fire and safety codes, and specified security, weather, earthquake, and wartime protection requirements; and existing facilities are maintained and repaired to provide continuous protection. Maintain the required capability to minimize facility loss or damage in the event of fire, natural disaster, or war.

4. Utility and Energy Supply and Conservation: Ensure adequate supply and efficient distribution of utilities to support mission requirements; and minimize facility energy consumption through proper design, location, and construction of new facilities, proper selection of energy sources, and maintenance, repair, and alterations of existing facilities.

5. Environmental Protection and Conservation: Ensure conservation of natural resources through land use planning and management. Prevent adverse environmental impact through proper construction and maintenance practices, and proper control and disposition of waste products and hazardous substances. Maintain required capability to minimize adverse environmental impact of fuel or oil spills.

TABLE 4--Continued

6. Facility Occupant/User Requirements: Ensure new facilities, additions, and alterations are designed and constructed to provide life safety protection, an acceptable level of comfort, a healthful environment, and aesthetic appeal; and existing facilities are maintained and repaired to sustain these standards throughout their lives. Maintain the required capability to minimize injury and loss of life due to facility conditions.

7. Other Non-facility Requirements: Ensure maximum base housing utilization and maximum service to personnel requesting on or off base housing. Provide fire protection, and crash and rescue capability to prevent injury or loss of life, and to minimize damage and loss of aircraft, vehicles, and equipment due to fire. Provide readiness capability to support war mobility requirements.

collectively by individual participants and supervisors, are measurable, and focus on specific local action areas requiring emphasis. The term "objective" for our model is used synonymously with the term "subgoal," and the ability to directly measure the objective is not required. These objectives are statements of desired conditions resulting from branch activities and are developed to direct the branch activities toward the strategic level organizational goals. Objective development must consider branch capabilities and established organizational desires. To develop branch objectives we focused on the following question. What processes is the branch capable of performing that can support the attainment of the strategic level organizational goals? Therefore, the objectives established for each branch are related to a strategic level organizational goal and consider branch activities capable of contributing to the attainment of these goals.

The capabilities of a specific branch are constrained by the specific set of resources assembled, including facilities, personnel, equipment, supplies, and technology. The branch resources are developed with the intent of providing the capability of performing the functional requirements outlined in AFR 85-10 and other civil engineering related Air Force regulations and manuals. The development of the branch objectives therefore focused on

the functional requirements of the branches presented in Chapter III. The resulting branch objectives are presented in Table 5.

## Performance Indicators

As stated in Chapter III, performance indicators contain two types of information; i.e., the actual output measurement in the numerator and the desired output in the denominator. The actual and desired outputs pertain to branch activities contributing to the attainment of a branch objective.

> A results measure is a measure of output expressed in terms that are supposedly related to an organization's objectives. In the ideal situation, the objective is stated in measurable terms. When this relationship is not feasible, as is often the case, the performance measure represents the closest feasible way of measuring the accomplishment of an objective that cannot itself be expressed quantitatively [3:141].

With the establishment of a goal/objective network for each branch completed, a review and analysis of the output/performance information presented in Chapter III was performed. The performance indicators, by definition, must be related to quality, quantity or timeliness of branch activities or customer satisfaction resulting from the activities.

The desired outputs are based upon local resources, capability, and priorities. Therefore, desired outputs are not reflected in the existing output/performance information presented in Chapter III. Occasionally a

TABLE 5

THE BRANCH LEVEL OBJECTIVES

Operations Branch

Goal #1--Facility Life Cycle Cost

A. Ensure work orders are planned in accordance with AFM 88-15 and applicable building codes.

B. Ensure completed work orders meet acceptable quality standards.

C. Provide an effective preventive maintenance program.

Goal #2--Facility Function

A. Ensure priority I work orders are planned and completed in a timely manner.

B. Ensure seasonal maintenance and repair requirements are identified, planned, programmed, and completed with the least disruption of facility functions.

C. Provide snow, ice, and debris removal services to prevent disruption of aircraft and vehicle movement, and interruption of facility function.

Goal #3--Facility Protection

A. Ensure priority II work orders are planned and completed in a timely manner.

B. Ensure work planned and completed complies with regional requirements for structural protection against weather and earthquake-related forces.

C. Provide a rapid response emergency recovery force capability for the protection of facilities in the event of civil disturbances, natural disasters, or war.

D. Ensure fixed facility fire and security protection systems are maintained in operable condition.

TABLE 5--Continued

E. Provide capability to expeditiously repair or secure damaged facilities to prevent further damage.

F. Provide control of insects and pests that threaten damage to facilities.

Goal #4--Utility and Energy Supply and Conservation

A. Minimize utility outages time and frequency through proper operations, maintenance, and expeditious repair.

B. Complete inspection of existing facilities to identify sources of energy waste.

C. Plan, program, and complete work orders identified as energy conservation projects, in a timely manner.

D. Minimize vehicle operations without compromising mission requirements.

Goal #5--Environmental Protection and Conservation

A. Ensure work orders to correct environmental hazards are planned, programmed, and completed in a timely manner to minimize adverse environmental impact.

B. Operate and maintain sewage collection and treatment facilities to ensure compliance with Environmental Protection Agency standards.

C. Provide response capability to minimize environmental impact due to fuel or oil spills.

Goal #6--Facility Occupant/User Requirements

A. Ensure planned work orders comply with base architectural interior and exterior design requirements.

B. Ensure planned work orders comply with the life safety and public health codes.

C. Ensure identified life safety code and health code deficiencies are corrected in a timely manner.

TABLE 5--Continued

D. Collect, transport, and dispose of solid wastes to minimize time between generation and disposal of wastes.

E. Ensure exterior landscaping, grooming, foliage control, and grass cutting are completed in a timely manner and comply with established standards.

F. Provide capability to expeditiously correct facility conditions that may cause injury or loss of life.

G. Ensure insects and pests are controlled that threaten humans with disease, injury, and loss of life.

H. Provide a rapid response emergency recovery force capability to minimize injury or loss of life due to facility conditions resulting from civil disturbances, natural disasters, or war.

Goal #7--Other Non-facility Requirements

A. Provide Prime BEEF mobility capability for rapid contingency deployment.

Engineering and Environmental Planning Branch

Goal #1--Facility Life Cycle Cost

A. Identify and program MCP projects, and monitor approval, design and construction phases to ensure maximum durability and maintainability of accepted facilities.

B. Ensure in-house design complies with AFM 88-15 and applicable building codes.

Goal #2--Facility Function

A. Ensure new construction projects are identified and programmed in a timely manner, and are designed and located in accordance with the user's requirements.

B. Identify and program contract corrections to facilities which are functionally inadequate for mission requirements.

TABLE 5--Continued

Goal #3--Facility Protection

A. Ensure corrective contract actions for identified facility fire, safety, and security deficiencies are programmed, designed, and completed in a timely manner.

B. Ensure new contract work complies with regional requirements for structural protection against weather and earthquake-related forces.

Goal #4--Utility and Energy Supply and Conservation

A. Complete engineering analyses of existing and programmed utility supply and distribution systems to identify inadequate supply or inefficient operations.

B. Ensure new facilities are designed and constructed to minimize energy consumption.

C. Complete engineering analyses of existing facilities to identify sources of energy waste, and program projects to correct deficiencies identified.

Goal #5--Environmental Protection and Conservation

A. Ensure facility projects are assessed for adverse environmental impact prior to programming.

B. Include environmental impact considerations during master planning actions, to minimize adverse impact due to siting.

C. Ensure control, handling and disposal of hazardous substances and waste products complies with EPA standards.

D. Ensure that construction practices comply with EPA standards.

Goal #6--Facility Occupant/User Requirements

A. Complete architectural studies of facilities to identify inadequate aesthetic conditions and facility deficiencies contributing to occupant discomfort.

TABLE 5--Continued

---

B. Ensure designed projects comply with applicable life safety and public health code requirements.

C. Ensure identified facility life safety and health code deficiencies requiring contract corrective action are programmed, designed, and completed in a timely manner.

D. Identify, program, and specify custodial contracts required for base facilities and ensure contractor compliance with the contractual requirements.

Goal #7--Other Non-facility Requirements

A. Provide professional architectural and engineering assistance to operations branch and to other organizations as required.

---

Fire Protection Branch

---

Goal #3--Facility Protection

A. Ensure contract designs comply with AFM 88-15 fire protection construction requirements and applicable National Fire Protection Association (NFPA) fire code requirements.

B. Ensure facilities fire protection deficiencies and existing fire protection systems that are inoperable are identified.

C. Provide response capability to minimize facility damage or loss due to fire.

D. Prevent damage to or loss of facilities through education of personnel in areas of safe housekeeping practices, hazardous activities, fire reporting, and fire fighting.

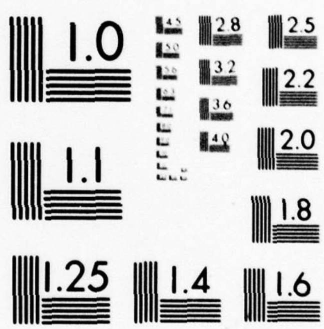
Goal #5--Environmental Protection and Conservation

A. Provide response capability to minimize environmental impact due to fuel or oil spills.

AD-A073 017   AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL--ETC   F/G 13/2
PRODUCTIVITY MEASUREMENT IN A BASE LEVEL USAF CIVIL ENGINEERING--ETC(U)
JUN 79   G P BAUMGARTEL, T D JOHNSON
UNCLASSIFIED   AFIT-LSSR-17-79A   NL

2 OF 2
AD A073 017

END
DATE
FILMED
9-79
DDC




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TABLE 5--Continued

Goal #6--Facility Occupant/User Requirements

A. Provide response capability to minimize injury or loss of life due to fire.

B. Ensure facility NFPA Life Safety Code deficiencies and existing egress and warning systems that are inoperable are identified.

C. Prevent injury or loss of life through education of personnel in areas of safe housekeeping practices, egress methods, and hazardous activities.

D. Ensure contract designs comply with AFM 88-15, Chapter 13, and the NFPA Life Safety Code.

Goal #7--Other Non-facility Requirements

A. Provide crash and rescue capability to prevent injury or loss of life, and to minimize damage or loss of property, due to aircraft, vehicle, and equipment fires.

Housing Branch

Goal #2--Facility Function

A. Identify base housing facility deficiencies.

Goal #6--Facility Occupant/User Requirements

A. Ensure housing conditions causing occupant discomfort are identified in a timely manner.

Goal #7--Other Non-facility Requirements

A. Provide family housing placement services to provide optimum use and allocation of family housing units.

B. Provide off-base referral services in a timely manner to satisfy customer requirements.

TABLE 5--Continued

| Industrial Engineering Branch |
| --- |
| **Goal #2--Facility Function**<br>A. Ensure organizations are assigned required facility space that is functionally adequate for mission requirements.<br>B. Identify facility space allocation overages and deficiencies for programming actions. |

required output is established by higher authority and a ratio of actual output to required output is provided to the base level civil engineering managers. Therefore, our search for performance indicators was consistent with the definition established in Chapter II and focused on: (1) actual output information currently recorded and made available to base level civil engineering managers, and (2) performance indicators established by policy directing required levels of outputs.

Therefore, the resulting matrix of performance indicators pertaining to specific branch objectives that support strategic level organizational goals contains either: (1) actual output measures, with the assumption that locally established desired output levels would be required to obtain the performance indicator ratio; or (2) performance indicators containing actual output measures divided by policy directed output levels. The results are presented in Table 6. A list of abbreviations used in Table 6 precedes that table.

List of Abbreviations Pertaining to Table 6

FAST - Fast Action Service Team

O&M - Operations and Maintenance

PCI - Pavement Condition Index

Pest - Pesticide application

RMP - Recurring Maintenance Program

SMART - Structural Maintenance and Repair Team

W.O. - Work Order

W.O.R. - Work Order Request

1255 - AF Form 1255, Quality Control Evaluation

TABLE 6

PERFORMANCE INDICATORS

Branch: Operations

| Goal # | Obj # | Quantity | Ref* | Quality | Ref | Timeliness | Ref | Cust. Satis. | Ref |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A | - | | - | | - | | - | |
| | B | - | | - | | - | | % 1255 Response Fav<br>Desired | 30<br>62<br>63 |
| | C | % RMP Hrs/Shop<br>Desired | 77 | % Variance Actual/Std Hrs<br>Desired | 78 | RMP Accomp<br>RMP Sched | 6<br>128 | | |
| | | Compl Rate<br>Desired | 128 | | | SMART Compl<br>SMART Sched | 51 | % SMART 1255 Responses Fav<br>Desired | 30<br>62<br>63 |
| | | | | | | Overdue RMP<br>Avg | 77 | | |

*Ref. = reference number from Tables 1, 2, and 3.

**TABLE 6--Continued**

| Goal # | Obj # | Performance Indicators | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Ref | Quality | Ref | Timeliness | Ref | Cust. Satis. | Ref |
| 2 | A | No. Priority I W.O. Compl<br>Avg | 53<br>90 | No. Priority I W.O. in Job Stoppage<br>Desired | 52<br>95 | No. Priority I W.O. with Mat 100% Compl 0-60 days<br>Desired | 39 | % 1255 Response (Priority I W.O.) Fav<br>Desired | 30<br>62<br>63 |
| | | | | % MNHR Variance for Priority I W.O.<br>Desired | 11<br>98<br>102 | No. Priority I W.O. with Mat 100% compl >60 days<br>Desired | 39 | | |
| | | | | | | Avg Time W.O.R. (Priority I) in Planning<br>Desired | 9<br>10<br>55 | | |
| | | | | | | Avg Time W.O. (Priority I) in Planning<br>Desired | 9<br>10<br>55 | | |
| | | | | | | No. Priority I Mat incompl (1st Future mo)<br>Desired | 58 | | |

TABLE 6--Continued

| Goal # | Obj # | Quantity | Ref | Quality | Ref | Timeliness | Ref | Cust. Satis. | Ref |
|---|---|---|---|---|---|---|---|---|---|
| | | Performance Indicators | | | | | | | |
| 2 (cont'd) | | | | | | | | | |
| | B | - | | - | | - | | - | |
| | C | - | | - | | - | | - | |
| 3 | A | No. Priority II W.O. Compl / Avg | 53 90 | No. Priority II W.O. in Job Stoppage / Desired | 52 95 | No. Priority II W.O. with Mat 100% Compl 0-60 days / Desired | 39 | % 1255 Response (Priority II W.O.) Fav / Desired | 30 62 63 |
| | | | | % MNHR Variance for Priority II W.O. / Desired | 11 98 102 | No. Priority II W.O. with Mat 100% Compl >60 days / Desired | 39 | | |
| | | | | | | Avg Time W.O.R. (Priority II) in Planning / Desired | 9 10 55 | | |
| | | | | | | Avg Time W.O. (Priority II) in Planning / Desired | 9 10 55 | | |

TABLE 6--Continued

| Goal # | Obj # | Quantity | Ref | Quality | Ref | Timeliness | Ref | Cust. Satis. | Ref |
|---|---|---|---|---|---|---|---|---|---|
| | | Performance Indicators | | | | | | | |
| 3 (cont'd) | A | | | | | No. Priority W.O. Mat Incompl (1st future mo) / Desired | 58 | | |
| | B | - | | - | | - | | - | |
| | C | Recovery Exercise Compl / Sched | 31 | Recovery Exercise Rating / Desired | 31 | - | | - | |
| | | | | % Veh Rqr / 100% | 18<br>19<br>43<br>43 | | | | |
| | | | | % Mat Rqr / 100% | 39 | | | | |
| | D | - | | - | | - | | - | |
| | E | % Direct Sched Work / Desired | 91 | - | | % Service Calls Accomp w/in 48 hrs / 100% | 2<br>46<br>53 | % 1225 Response Pav (Direct Sched Work) / Desired | 30<br>62<br>63 |

TABLE 6--Continued

| Goal # | Obj # | Quantity | Ref | Quality | Ref | Timeliness | Ref | Cust. Satis. | Ref |
|---|---|---|---|---|---|---|---|---|---|
| | | Performance Indicators | | | | | | | |
| 3 (cont'd) | E | | | | | % Fast Calls Accomp w/in 5 Days / 100% | 3 46 53 | | |
| | | | | | | % Hopper Calls Accomp w/in 30 Days / 100% | 4 5 46 53 | | |
| | F | - | | - | | Total Exterior Area Pest Treated / Sched | 74 | - | |
| | | | | | | Total SF Bldg Pest Treated / Sched | 74 | | |
| 4 | A | Days w/o Power Outage/month / Desired | 8 | % Emerg Generator Op / Desired | 8 | Utility Sys Fclty Insp / Sched | 12 55 | - | |
| | | | | Generator Op Time/Period / Required | 8 | | | | |

TABLE 6--Continued

| Goal # | Obj # | Quantity | Ref | Quality | Ref | Timeliness | Ref | Cust. Satis. | Ref |
|---|---|---|---|---|---|---|---|---|---|
| | | Performance Indicators | | | | | | | |
| 4 | B | | | | | No. Energy Fclty Insp / No. Sched | 12 | | |
| | C | - | | - | | - | | - | |
| | D | Weekly Avg No. Trips/Taxi/Day / Desired | 67 | - | | - | | - | |
| 5 | A | - | | - | | - | | - | |
| | B | - | | - | | - | | - | |
| | C | - | | - | | - | | - | |
| 6 | A | - | | - | | - | | - | |
| | B | % W.O. Planned Coord w/ Base Safety / 100% | 100 | - | | - | | - | |
| | | % W.O. Planned Coord w/ Bio-Envmtl Engr / 100% | 100 | - | | - | | - | |

TABLE 6--Continued

| Goal # | Obj # | Quantity | Ref | Quality | Ref | Timeliness | Ref | Cust. Satis. | Ref |
|---|---|---|---|---|---|---|---|---|---|
| | | Performance Indicators | | | | | | | |
| 6 | C | No. Priority II W.O. Compl/Period / Avg | 53 90 | No. Priority II W.O. in Job Stoppage / Desired | 52 95 | No. Priority II W.O. with Mat 100% Compld-60 Days / Desired | 39 | % 1255 Response (Priority II W.O.) Fav / Desired | 30 62 63 |
| | | | | % MNHR Variance for PRIORITY II W.O. / Desired | 11 98 102 | No. Priority II W.O. with Mat 100% Compld->60 Days / Desired | 39 | | |
| | | | | | | Avg Time W.O.R. (Priority II) in Planning / Desired | 9 10 55 | | |
| | | | | | | Avg Time W.O. (Priority II) in Planning / Desired | 9 10 55 | | |
| | | | | | | No. Priority W.O. Mat Incompl (1st Future Mo) / Desired | 58 | | |

TABLE 6--Continued

| Goal # | Obj # | Quantity | Ref | Quality | Ref | Timeliness | Ref | Cust. Satis. | Ref |
|---|---|---|---|---|---|---|---|---|---|
| | | Performance Indicators | | | | | | | |
| 6 | D | - | | Insp Eval / Desired | 26 | - | | - | |
| | E | - | | - | | - | | - | |
| | F | - | | - | | % Service Calls Accomp W/IN 48 Hrs / 100% | 2 46 53 | % 1225 Response Fav (Service Calls) / Desired | 30 62 63 |
| | G | Recovery Exercise Compl / Sched | 31 | Recovery Exercise Rating / Desired | 31 | - | | - | |
| | | | | % Veh Rqr / 100% | 18 19 42 43 | | | | |
| | | | | % Mat Rqr / 100% | 39 | | | | |
| 7 | A | Exercise Compl Prime BEEF Mobility Team / Sched | 31 | Mobility Exercise Rating / Desired | 31 | - | | - | |

TABLE 6--Continued

| Goal # | Obj # | Performance Indicators | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | Ref | Quality | Ref | Timeliness | Ref | Cust. Satis. | Ref |
| 7 (cont'd) | A | - | | AFR 93-3 Eval / Desired | 24<br>41<br>93<br>94 | - | | - | |
| Engineering and Environmental Planning | | | | | | | | | |
| 1 | A | - | | Avg Pavement Index (PCI) / Desired Avg | 114 | - | | - | |
| | B | - | | - | | - | | - | |
| 2 | A | - | | - | | % of Engrg Design W.O. in Work Stoppage / Desired % | 124 | - | |
| | B | % Force-Use Fclty w/ Prgm Proj / Desired % | 85<br>122 | - | | No. Fclty Insp / Sched Insp | 12 | - | |
| 3 | A | - | | - | | - | | - | |

TABLE 6--Continued

| Goal # | Obj # | Quantity | Ref | Quality | Ref | Timeliness | Ref | Cust. Satis. | Ref |
|---|---|---|---|---|---|---|---|---|---|
| | | Performance Indicators | | | | | | | |
| 3 | B | - | | - | | - | | - | |
| 4 | A | - | | - | | No. Util Sys Fclty Insp / Sched Insp | 12 | - | |
| | B | - | | - | | No. Fclty Energy Insp / Sched Insp | 12 | - | |
| 5 | A | - | | - | | - | | - | |
| | B | - | | - | | - | | - | |
| | C | - | | - | | - | | - | |
| | D | - | | - | | - | | - | |
| 6 | A | - | | - | | No. Arch Fclty Insp / Sched Insp | 12 | - | |
| | B | - | | - | | - | | - | |
| | C | - | | - | | - | | - | |

TABLE 6--Continued

| Goal # | Obj # | Quantity | Ref | Quality | Ref | Timeliness | Ref | Cust. Satis. | Ref |
|---|---|---|---|---|---|---|---|---|---|
| | | Performance Indicators | | | | | | | |
| 6 | D | % Fclty w/ Custodial Contr / % Auth | 25 | Insp Eval / Desired | 25 | - | | Custodial Contr Customer Eval / Desired | 30 |
| 7 | A | No. Engrg Eval of O&M W.O./ Period / Avg No. | 100 | - | | Avg Review Time/ W.O. / Desired | 100 | - | |
| | | Fire Protection | | | | | | | |
| 3 | A | % W.O. Eval / 100% | 100 | - | | Avg Review Time/ W.O. / Desired | 100 | - | |
| | B | % Fclty Insp/Wk / % Desired | 29 67 | $ Fire Loss Due to Falty Deficiency/ Period / $ Avg | 28 32 | Tech Svc Insp Compl / Insp Sched | 29 67 | - | |
| | C | Responses Current Period / Avg Responses | 28 32 | Last Exercise Eval / Desired | 27 | - | | - | |

TABLE 6--Continued

| Goal # | Obj # | Quantity | Ref | Quality | Ref | Timeliness | Ref | Cust. Satis. | Ref |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Performance Indicators** | | | | | |
| 3 (cont'd) | C | Total Tng/Period / Desired | 28 32 | Mo Avg Structural Veh in-comsn Rate / Desired | 20 32 | Tng Accomp / Tng Sched | 26 32 | - | |
| | | | | Mo Min Structural Veh in-comsn Rate / Desired | 20 32 | | | | |
| | D | - | | # Fire Loss Due to Pers Actn / $ Avg | 28 32 | - | | - | |
| 6 | A | Total Tng/Period / Desired | 28 32 | Last Exercise Eval / Desired | 27 | Tng Accomp / Tng Sched | 26 32 | - | |
| | | No. Responses Current Period / Avg Responses | 28 32 | Mo Avg Crash/Rescue Veh in-comsn Rate / Desired | 20 32 | - | | - | |

TABLE 6--Continued

| Goal # | Obj # | Performance Indicators: Quantity | Ref | Quality | Ref | Timeliness | Ref | Cust. Satis. | Ref |
|---|---|---|---|---|---|---|---|---|---|
| 6 (cont'd) | A | - | | Mo Min Crash/Reserve Veh in-comsn Rate / Desired | 20 32 | - | | - | |
| | B | % Fclty Insp/Wk / % Desired | 29 67 | - | | Tech Svc Insp Compl / Insp Sched | 29 67 | - | |
| | C | No. Contr Briefings Compl/Period / No. Required | 13 29 44 67 | $ Fire Loss Due to Contr Op / Avg $ Loss | 28 32 | - | | - | |
| | D | % Design W.O. Eval / 100% | 100 | - | | - | | - | |
| 7 | A | No. Responses Current Period / Avg Responses | 28 32 | Last Exercise Eval / Desired | 27 | Tng Accomp / Tng Sched | 26 32 | - | |

TABLE 6--Continued

| Goal # | Obj # | Quantity | Ref | Quality | Ref | Timeliness | Ref | Cust. Satis. | Ref |
|---|---|---|---|---|---|---|---|---|---|
| | | **Performance Indicators** | | | | | | | |
| 7 (cont'd) | A | Total Tng/Period / Desired | 26 32 | Mo Avg Crash/Rescue Veh In-comsn Rate / Desired | 20 32 | - | | - | |
| | | | | Mo Min Crash/Rescue Veh In-comsn Rate / Desired | 20 32 | | | | |
| | B | No. Responses Current Period / Avg Responses | 28 32 | - | | Avg Response Time / Desired | 28 32 | - | |
| | | **Family Housing** | | | | | | | |
| 2 | A | - | | - | | - | | - | |
| 6 | A | - | | - | | - | | - | |
| 7 | A | - | | Occupancy Rate / 99% | 14 68 | Avg Mo Turn-around Time / 3 Days | 15 | - | |

TABLE 6--Continued

| Goal # | Obj # | Quantity | Ref | Quality | Ref | Timeliness | Ref | Cust. Satis. | Ref |
|---|---|---|---|---|---|---|---|---|---|
| 7 | B | - | | - | | - | | - | |
| | | | | Industrial Engineering | | | | | |
| 2 | A | - | | % Class A Fclty Desired | 85 | Ave Time Since Last Inventory Desired | 84 | - | |
| | B | - | | % Space Overage Desired | 88 | - | | - | |
| | | | | % Space Deficient Desired | 88 | | | | |

## CHAPTER V

## SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

### Summary

The purpose of this research was to determine whether a model for measuring the productivity of a base level USAF civil engineering squadron could be developed. The initial effort concentrated on defining productivity for a nonprofit, service organization. Four concepts arose during this phase: efficiency, the relationship between the work performed and the amount of effort put into its performance; effectiveness, the appropriateness of the work performed; output, a quantitative measure of the work performed; and input, a quantitative measure of the effort or resources expended in performing the work. It was found that a process could be highly efficient, have large output relative to the input, but that the process could at the same time be ineffective, not appropriate. It was felt, therefore, that a method for measuring productivity must include both efficiency and effectiveness.

The measurement of efficiency may be done by evaluating the ratio of output to input at any level within an organization. The measurement of effectiveness required

the evaluation of both direction and adequacy of the work performed.

In order to accomplish this evaluation of direction, it was determined that a structure of strategic level goals and intermediate level objectives had to be developed for the organization being evaluated. The adequacy of the work performed could then be evaluated by relating the actual results obtained to desired results. The desired results would be identified through a management technique such as Management by Objectives or through direction from higher authoritative levels within the organization.

The measurement of productivity through the evaluation of efficiency and effectiveness led to the modification of the definition of productivity for a profit organization, which is the ratio of output to input, to the definition in Chapter II which is the sum of all the ratios of actual results to desired results at any organizational level, divided by the total input at that level.

The second phase of this research concentrated on the application of the above definition of productivity measurement to a base level USAF civil engineering organization. This required a second literature review, consisting of a search of existing Department of Defense and Air Force literature to identify the strategic level organizational goals and branch level objectives which support those goals that are set forth by higher headquarters applicable to

all base level USAF civil engineering organizations. The literature review also included a systematic search through major sources of management information for output and input data required for productivity measurement.

The model for productivity measurement depicted in Figure 3 formed the basis for structuring the goals, objectives and performance indicators identified in the second literature review, which are presented in Tables 4, 5, and 6.

The criteria for selecting sources of information was based upon formally documented sources available at a typical base level civil engineering organization. It is realized that many other sources of information for output data exist and that locally established manual record keeping systems are established.

Many of the 85-X through 93-X series Air Force regulations and manuals required formal methods of record keeping; for example, facility folders, contract files, and programming documents. Additionally, formal records of emergency requests are contained in the service call log and the fire department control center log. Individual work order and job order folders contain information about adequacy of planning or design, economic studies, energy calculations, and structural considerations, for example. Furthermore, the Engineering and Environmental Planning Branch locally records engineer and architect studies

resulting from technical assistance requests from the Operations Branch or outside sources. Construction management project log books also provide a source of documented evidence concerning construction quality. Specific efforts to schedule engineers' and architects' time for particular requirements are also recorded. Additionally, professional training accomplishments are also recorded for assigned architects and engineers. Furthermore, master planning efforts, and facility space deficiencies and overages are items of interest briefed at Facilities Boards on a recurring basis.

Family housing occupant information is recorded manually by the Housing Branch and family housing facility inspection records are also maintained. Finally, in addition to the internal base civil engineering information, outside sources of information are available which for example include: Environmental Protection Agency (EPA) permits and reports; bio-environmental health reports and industrial hygiene surveys; effluent sampling records; water usage records; utility outage records for electrical distribution; base operation's airfield inspections and runway condition reading (RCR) recorded during snowfall and ice periods; building custodian records; air traffic control board minutes; security police resource protection reports and facility incident reports; traffic planning board

minutes; and evaluations by facility occupants through Base Commander's "hotline" programs.

## Conclusions

The results of this research have caused us to draw the following conclusions:

1. The productivity of a base level USAF civil engineering organization can be measured utilizing the model presented in this thesis. The model allows for the measurement of productivity at the branch level for specific time intervals which in turn can be used to evaluate productivity trends over time. This method of measuring productivity is based upon the framework of strategic level organizational goals and branch level objectives which can be measured by evaluating actual results, desired results and inputs.

2. The strategic level organizational goals for a base level USAF civil engineering organization can be identified from existing Department of Defense and Air Force literature.

3. Branch level objectives to support the strategic level operational goals can be identified from existing Department of Defense and Air Force literature. These objectives may require modification for individual base level civil engineering organizations due to specific major command (MAJCOM) or base mission requirements.

4. A limited number of performance indicators can be identified from existing Department of Defense and Air Force literature. Most of the existing output information is grouped by organization functional areas and categorization by objectives was difficult. For those objectives requiring a readiness or response capability, a definition of capability did not exist. Therefore, direct output measurement could not be obtained and surrogate measurement was difficult. The inclusion of training or exercise evaluation results as actual output information is questionable. Finally, few output requirements are specified at levels above the base organization, and therefore the desired output level must be locally established at base level to evaluate performance.

5. Input data is available in great detail and can be identified at almost any level within the organization and for almost any activity performed by the organization.

## Recommendations

The purpose of this research was to provide a base level USAF civil engineering branch level manager with a method for measuring the productivity of his/her area of responsibility. Based upon the conclusions drawn from the research, the following recommendations have been developed in two areas; further research and applications.

## Further Research

The recommendations for further research are the validation of the strategic level organizational goals and the branch level objectives presented in Chapter IV, development of additional output measurements and possible inclusion of these measurements in BEAMS. It was first felt by the researchers that validation of possible goals, objectives and performance indicators should be performed by the Base Civil Engineers and the branch chiefs. Therefore, questionnaires were developed to perform this validation. This method of validation was later rejected for two reasons: (1) the questionnaire was massive and time-consuming, containing over 250 questions, many of which required written comments which would have been difficult to include in the final results; and (2) it was felt that a thorough review of Department of Defense and Air Force literature would provide a more meaningful initial validation of the goals and objectives than a base level questionnaire, and that performance indicators should be initially identified from existing output measurements.

The first recommendation for further research is that the final validation of the goals and objectives be performed at the Air Force Directorate of Engineering and Services level and that this validation be a continual process because the environment surrounding a base level civil engineering organization changes over time.

The second recommendation for further research is for development of additional output measurement data for branch level activities, that support the branch objectives, and will be used for evaluating the results of civil engineering performance. Anthony and Herzlinger stated,

> Some measure of output is usually better than none. Valid criticisms can be made about almost every output measure. Few, if any, of them measure output perfectly. There is a tendency on the part of some managers to magnify the imperfections and thus downgrade the attempt to collect and use output information. In most situations a sounder approach is to take account of the imperfections and to qualify the results accordingly, but to recognize that some output data, however crude, is of more use of management than no data at all [3:148].

Currently a great amount of information on inputs to a base level USAF civil engineering organization is recorded and made available to branch level managers, but recorded output information is generally nonexistent and therefore adequate productivity evaluation is currently impossible. Consequently, a complete series of branch level activities output measurements should be developed.

The final recommendation of further research is the possible modification of the Base Engineer Automated Management System (BEAMS) to collect branch level activity output data required for measuring productivity.

<u>Application</u>

The application of this method of measuring the productivity of a base level USAF civil engineering organization is dependent upon the completion of these

recommendations for further research. As stated previously, increased emphasis on output measurement must occur before productivity measurement is possible. The output information should be structured according to the organizational goals and branch level objectives. Ideally, a revision of BEAMS to include the proposed productivity measurement model should be accomplished.

Therefore, in addition to input and output data structured according to organizational goals and branch objectives, a means for allowing local branch level input of desired output levels is required. Automated record keeping and qualitative manipulation is required to relieve managers from a time-consuming manual recording and calculating system. A periodic computer product distributed to the Base Civil Engineer and the individual branch managers including current and past productivity indices would allow for trend analysis of performance achieved for resources consumed.

SELECTED BIBLIOGRAPHY

## A. REFERENCES CITED


1. Air Force Institute of Technology, Civil Engineering School. A Guide to Base Level Industrial Engineering. Wright-Patterson AFB OH, undated.

2. ________. School of Civil Engineering, Commander's Update Briefing. Wright-Patterson AFB OH, undated.

3. Anthony, Robert N., and Regina Herzlinger. Management Control in Nonprofit Organizations. Homewood IL: Richard D. Irwin, Inc., 1975.

4. Arnold, Palmer G., Captain, USAF, and Captain David F. Fink, USAF. "Hierarchical Model of Objectives and Performance Indicators for the Base Civil Engineer." Unpublished master's thesis. Air Force Institute of Technology, Wright-Patterson AFB OH, 1974.

5. Berkowitz, Edward R. "Management by Results," Air Force Civil Engineer, November 1978, pp. 2-5.

6. Carter, Jimmy, President. Federal Compliance with Pollution Control Standards. Executive Order 12088. Washington: The Bureau of National Affairs, Inc., October 13, 1978.

7. Civil Engineering and Services Management Engineering Team. Civil Engineering Status Briefing (suggested format). Draft. Tyndall AFB FL, December 1978.

8. Courter, Rober J., Jr., Major, USAF. "Base Level Management Plan," Air Force Engineering and Services Quarterly, May 1978.

9. Eilor, Samuel, Bela Gold, and Judith Soesan. Applied Productivity Analysis for Industry. Oxford: Pergamon Press, Ltd., 1976.

10. Fritsch, Martin M., and James G. Zody, Major, USAF. "O&M The Heart of Civil Engineering," Air Force Engineering & Services Quarterly, November 1978, pp. 2-3.

11. Fulton, Darrell N., and Donald D. Wright. DOD Resource Management Systems System for Management of Operations: Accounting and Reporting. 2d ed. School of Systems and Logistics Textbook LS 23, Wright-Patterson AFB OH, December 1978.

12. Gansler, Jacques S. "Comment," Defense Management Journal, April 1977, p. 1.

13. Gilbert, William D., Major General, USAF. "Air Force Real Property Maintenance," The Military Engineer, March-April 1979, pp. 80-81.

14. Glaser, Edward M. Productivity Gains Through Worklife Improvements. New York: Harcourt, Brace, Jovanovich, 1976.

15. Goddard, Guy H., Major General, USAF. "Productivity of the Work Force," Air Force Civil Engineer, November 1970, p. 1.

16. Gold, Bela. Foundations of Productivity Analysis. Pittsburgh: University of Pittsburg Press, 1955.

17. Grayson, C. Jackson, Jr. "Eight Ways to Raise Productivity and Profits," Nation's Business, September 1972, pp. 30-36.

18. Greenburg, Leon. A Practical Guide to Productivity Measurement. Washington: The Bureau of National Affairs, Inc., 1973.

19. Heaton, Herbert. Productivity in Service Organizations (Organizing for People). New York: McGraw-Hill, Inc., 1977.

20. Kast, Fremont E., and James E. Rosenzweig. Organization Management: A Systems Approach. 2d ed. New York: McGraw-Hill, Inc., 1974.

21. Katzell, Raymond A., and Daniel Yankelovich. "Improving Productivity and Job Satisfaction," Organizational Dynamics, Summer 1974, pp. 69-75.

22. King, Norwood J., Lieutenant Colonel, USAF. "How to Increase Work Force Productivity," Air Force Engineering & Services Quarterly, August 1975, p. 6.

23. Lawler, Edward E., III. "For a More Effective Organization--Match the Job to the Man," Organizational Dynamics, Summer 1974, pp. 19-29.

24. Lupton, Thomas. "Efficiency and the Quality of Worklife," Organizational Dynamics, Autumn 1975, pp. 68-80.

25. Mali, Paul. Improving Total Productivity. New York: John Wiley & Sons, 1978.

26. Mark, Jerome A. "Better Federal Coverage Needed to Improve National Measurement," Defense Management Journal, October 1972, pp. 12-15.

27. Mayes, Archie S., Brigadier General, USAF. "A Blueprint for Improvement," Air Force Civil Engineer, November 1970, pp. 2-4.

28. McCarthy, James E., Major, USAF, and Major Charles B. Voss, USAF. "AFR 85X Management Maintenance Test . . . (toward reducing the impediments to productivity)," Air Force Engineering & Services Quarterly, August 1977, pp. 2-5.

29. McClean, David. "Productivity: Everybody Says You Need It, How Do You Get It?" Nation's Business, September 1972, pp. 66-68.

30. Nadler, Gerald. "Is More Measurement Better?" Industrial Engineering, March 1978, pp. 20-25.

31. Power, Richard J. "Productivity: A Defense Department Perspective," Defense Management Journal, April 1977, pp. 2-8.

32. Sirota, David. "Productivity Management," Harvard Business Review, September-October 1966, pp. 111-116.

33. Smith, O. F., Lieutenant Colonel, USAF. "Our Ability to Fly and Fight: A Matter of Readiness," Air Force Engineering & Services Quarterly, November 1977, pp. 3-7.

34. Steers, Richard M. "Problems in the Measurement of Organizational Effectiveness," Administrative Science Quarterly, December 1975, pp. 546-558.

35. ________. "When is an Organization Effective? A Process Approach to Understanding Effectiveness," Organizational Dynamics, Autumn 1976, pp. 50-63.

36. Stewart, William T. "A 'Yardstick' for Measuring Productivity," Industrial Engineering, February, 1978, pp. 34-37.

37. Tetra Tech, Inc. U.S. Air Force Energy Plan 1978. Tetra Tech Document TT-A-886-78-369. Arlington VA, July 1978.

38. Thompson, Robert C., Major General, USAF. "A 'Total Environment' Approach to Our Jobs," Air Force Engineering & Services Quarterly, August 1976, p. 1.

39. ________. "Are We Ready?" Air Force Engineering & Services Quarterly, November 1977, p. 2.

40. ________. "On Breaking with Tradition," Air Force Engineering & Services Quarterly, May 1976, p. 1.

41. ________. "Service: Special Obligations . . . and Opportunities," Air Force Engineering & Services Quarterly, May 1976, p. 1.

42. U.S. Air Force Engineering and Services Center. Facility Energy Fact Book. Tyndall AFB FL, 1979.

43. ________. Strawman Air Force Ten Year Facility Plan FY 76-85. Tyndall AFB FL, 1979.

44. U.S. Department of the Air Force. Airfield and Base Snow and Ice Removal and Control. AFR 91-14. Washington: Government Printing Office, 5 June 1973.

45. ________. Air Force Design Manual Criteria and Standards for Air Force Construction. AFM 88-15. Washington: Government Printing Office, 20 August 1976.

46. ________. Air Force Inventory and Utilization of Military Family Housing. AFR 90-6. Washington: Government Printing Office, 31 October 1975.

47. ________. Assignment of Family Housing. AFR 90-1. Washington: Government Printing Office, 19 December 1977.

48. ________. Base Engineering Automated Management System (BEAMS). AFM 171-200, Vol. II. Washington: Government Printing Office, 13 September 1977.

49. ________. Corrosion Control. AFR 91-27. Washington: Government Printing Office, 10 September 1976.

50. ________. Custodial Service. AFR 91-30. Washington: Government Printing Office, 31 July 1973.

51. ________. Design and Construction Management. AFR 89-1. Washington: Government Printing Office, 20 June 1978.

52. ________. Disaster Preparedness and Base Recovery Planning. AFR 93-2. Washington: Government Printing Office, 20 July 1974.

53. ________. Disposal of Real Property. AFR 87-4. Washington: Government Printing Office, 23 April 1971.

54. ________. Fire Protection Program. AFR 92-1. Washington: Government Printing Office, 20 March 1974.

55. ________. Master Planning. AFR 86-4. Washington: Government Printing Office, 30 November 1966.

56. ________. Military Entomology Handbook. AFM 91-16. Washington: Government Printing Office, December 1971.

57. ________. Operating and Maintaining Air Force Family Housing.. AFR 91-1. Washington: Government Printing Office, 12 September 1975.

58. ________. Operation and Maintenance of Prime BEEF. AFM 93-6. Washington: Government Printing Office, 8 March 1972.

59. ________. Operation and Maintenance of Real Property. AFR 85-10. Washington: Government Printing Office, 24 October 1975.

60. ________. Pest Management Program. AFR 91-21. Washington: Government Printing Office, 10 February 1975.

61. ________. Policies, Procedures, and Criteria for the Management and Conservation of Utilities. AFM 91-12. Washington: Government Printing Office, 19 August 1971.

62. ________. Pollution Abatement and Environmental Quality. AFR 19-1. Washington: Government Printing Office, 9 January 1978.

63. ________. Programming Civil Engineering Resources. AFM 86-1. Washington: Government Printing Office, 26 September 1973.

64. ________. Resources and Work Force Management. AFR 85-1. Washington: Government Printing Office, 22 September 1978.

65. ________. Standard Facility Requirements. AFM 86-2. Washington: Government Printing Office, 2 June 1975.

66. ________. The Prime BEEF Program. AFR 93-3. Washington: Government Printing Office, 15 March 1971.

67. ________. Use of Real Property Facilities. AFR 87-2. Washington: Government Printing Office, 5 March 1976.

68. ________. Utilities Services. AFR 91-5. Washington: Government Printing Office, 13 October 1976.

69. U.S. Department of Commerce. "Most Industries Reflect Decade of Slower Productivity Growth," Commerce America, August 28, 1978, pp. 18-19.

70. U.S. Department of Defense. Accident Prevention, Safety, and Occupational Health Policy for the Department of Defense. DOD Directive 1000.3. Washington: Government Printing Office, June 15, 1976.

71. ________. Construction Criteria. DOD Directive 4270.1. Washington: Government Printing Office, February 16, 1978.

72. ________. Department of Defense Pest Management Program. DOD Directive 4150.7. Washington: Government Printing Office, August 30, 1974.

73. ________. Policy and Criteria for Operation, Maintenance, and Repair of Defense Family Housing. DOD Instruction 4270.21. Washington: Government Printing Office, October 2, 1973.

74. ________. Protection and Enhancement of Environmental Quality. DOD Directive 5100.50. Washington: Government Printing Office, May 24, 1973.

75. ________. Utilization and Retention of Real Property. DOD Directive 4165.20. Washington: Government Printing Office, August 29, 1958.

76. U.S. Department of Labor. "Productivity Measurement and Effectiveness Measurement," Monthly Labor Review, December 1972, p. 6.

77. Vitale, Anthony M., Lieutenant Colonel, USAF. "Air Force Civil Engineering Must Lead the Way," Air Force Civil Engineer, August 1974, pp. 8-9.

78. Wilson, Louis L., Jr., General, USAF. "People: Our Most Important Resource," TIG Brief, 25 February 1977, p. 2.

## B. RELATED SOURCES

Berger, Chris J., and L. L. Cummings. "Organization Structure: How Does it Influence Attitudes and Performance?" Organizational Dynamics, Autumn, 1976, pp. 34-50.

Chase, Richard B., and Nicholas J. Aquilano. Production and Operations Management: A Life Cycle Approach. Revised edition. Homewood IL: Richard D. Irwin, Inc., 1977.

Child, John. "What Determines Organization Performance?" Organization Dynamics, Summer, 1974, pp. 2-18.

"Council on Environmental Quality, Executive Office of the President." Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act. Washington: Government Printing Office, November 1978.

Emory, C. William. Business Research Methods. Homewood IL: Richard D. Irwin, Inc., 1976.

Farris, George F. "Chickens, Eggs, and Productivity in Organizations," Organizational Dynamics, Spring, 1975.

Hughes, Charles L. "Goal Oriented Approaches to People and Job Measurement," in Arthur Beck and Ellis Hillmar, eds., A Practical Approach to Organizational Development Through MBO: Selected Readings. Reading MA: Addison-Wesley Publishing Co., 1972.

Kassouf, Sheen. Normative Decision Making. Englewood Cliffs NJ: Prentice Hall, 1970.

Katzell, Mildred E. Productivity: the Measure and the Myth. New York: AMACOM, 1975.

Kennedy, James R., Captain, USAF. Industrial Engineering Management Brochure. Air Force Institute of Technology, Civil Engineering School, 1 April 1978.

Kotter, John P. "Power, Success, and Organizational Effectiveness," Organizational Dynamics, Winter 1978, pp. 26-41.

Morrisey, George L. Management by Objectives and Results for Business and Industry. 2d ed. Reading MASS: Addison-Wesley Publishing Co., 1977.

Mott, Paul E. The Characteristics of Effective Organizations. New York: Harper & Row, Publishers, 1972.

National Bureau of Economic Research, Inc. Output, Input, and Productivity Measurement. Vol. 25. Princeton: Princeton University Press, 1961.

Odiorno, George. Management Decisions by Objectives. Englewood Cliffs NJ: Prentice-Hall, 1970.

Schlek, Edward C. "The Fallacy in Measurement Management," Dun's Review, November 1963, p. 49.

Schoderbek, Peter E., Asterios G. Kefacas, and Charles G. Schoderbek. Management Systems: Conceptual Considerations. Dallas: Business Publications, Inc., 1975.

U.S. Department of the Air Force. Environmental Quality Control Handbook. AFP 19-5. Washington: Government Printing Office, 15 October 1975.

U.S. Department of Defense. Department of Defense Occupational Safety and Health (OSH) Program. DOD Instruction 6055.1. Washington: Government Printing Office, January 30, 1978.

________. Minor Construction and Restoration or Replacement of Facilities Damaged or Destroyed--Programs. DOD Directive 4270.24. Washington: Government Printing Office, November 5, 1976.

U.S. Department of Labor. "Productivity in the Federal Government," Monthly Labor Review, November 1974, pp. 12-20.

Wolfram, Carl B. "'Think Maintainability'--A Word to the Designer," The Military Engineer, March-April 1979, pp. 88-89.